EUNOIA JUNIOR COLLEGE
JC1 Promotional Examination 2021
General Certificate of Education Advanced Level
Higher 2

PHYSICS 9749

MARK SCHEME

Sep/Oct 2021

Paper 1
Multiple Choice

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

1 Rubik's cube is approximately (5 cm)^3.
\# of cubes

$$\approx \left(\frac{18}{0.05}\right)\times\left(\frac{9.5}{0.05}\right)\times\left(\frac{4}{0.05}\right)$$

$$\approx 10^6$$

2 $\dfrac{a\lambda}{2\pi}+\dfrac{2\pi b}{\rho\lambda}$ have same units as v^2

$$\text{units of } \frac{a\lambda}{2\pi} = \text{units of } \frac{2\pi b}{\rho\lambda} = \text{m}^2\ \text{s}^{-2}$$

$$\text{units of } a = \frac{\text{m}^2\ \text{s}^{-2}}{\text{units of } \lambda} = \frac{\text{m}^2\ \text{s}^{-2}}{m} = \text{m s}^{-2}$$

$$\text{units of } b = \frac{\text{m}^2\ \text{s}^{-2}}{\text{units of } \frac{1}{\rho\lambda}} = \frac{\text{m}^2\ \text{s}^{-2}}{\left[(\text{kg m}^{-3})(\text{m})\right]^{-1}} = \text{kg s}^{-2}$$

3

$$\rho = \frac{m}{\text{volume}} = \frac{m}{\frac{4}{3}\pi r^3} = \frac{m}{\frac{4}{3}\pi\left(\frac{d}{2}\right)^3} = \frac{6m}{\pi d^3}$$

$$\rho = \frac{6(12.6)}{\pi 1.85^3} = 3.8006 \text{ g cm}^{-3}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta d}{d}$$

$$\Delta\rho = \rho\left(\frac{\Delta m}{m} + 3\frac{\Delta d}{d}\right) = (3.8006)\left(\frac{0.1}{12.6} + 3\frac{0.01}{1.85}\right) \approx 0.1 \text{ g cm}^{-3}$$

$$\rho = 3.8 \pm 0.1 \text{ g cm}^{-3} \text{ (round UP)}$$

4 displacement increases with time: *j*
velocity increases until $v_{terminal}$: *h*
acceleration decrease to zero: *k*

5 disregarding wall, at max height, zero vertical velocity:

$$v^2 = u^2 + 2as$$
$$0 = (u\ \sin\ \theta)^2 - 2gs_{\text{max}}$$
$$s_{\text{max}} = \frac{(10\ \sin\ 30°)^2}{2(9.81)} \approx 5.1\ \text{m}$$

time to reach 5.1 m vertical displacement:

$$v = u + at$$
$$t = \frac{v_y - u_y}{g} = \frac{0 - u\ \sin\ 30°}{-9.81}$$
$$\approx 0.51\ \text{s}$$

time to reach wall:

$$s_x = v_x t$$
$$t = \frac{s_x}{v_x} = \frac{3.5}{10\ \cos\ 30°}$$
$$\approx 0.40\ \text{s}$$

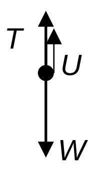
so ball will hit wall before reaching max possible displacement:

$$s_y = u_y t + \frac{1}{2}at^2$$
$$= (u\ \sin\theta)\left(\frac{s_x}{v_x}\right) + \frac{1}{2}g\left(\frac{s_x}{v_x}\right)^2$$
$$= 1.2\ \text{m}$$

6 Rod horizontal so same tension in stings

P and Q displace same volume of fluid V

$U = \rho V g$ so denser liquid gives more upthrust



for either objects:

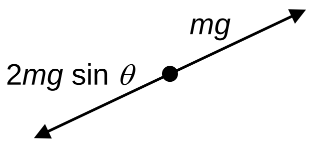
$$m = \frac{W}{g} = \frac{T+U}{g}$$

object in less-dense liquid has less mass

7 first 3 s no drag so constant a = 9.81 m s^{-2}
eliminate options B and C

parachute causes a sudden and large upward force (different direction) so net force/acceleration changes direction

8 total force downramp = $2mg\ \sin\theta$
max possible friction = mg



$$2mg\ \sin\theta = mg$$
$$\sin\theta = 0.5$$
$$\theta = 30°$$

9 Inelastic collision so KE not conserved.
eliminate B

Isolated system so total system momentum conserved
eliminate A and C

verify option D:

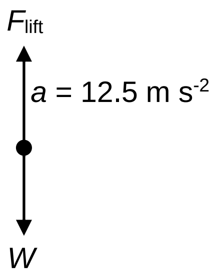
by PCLM

$$mu + 0 = 2mv$$
$$v = \frac{1}{2}u$$

KE of either mass after collision

$$\frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{u}{2}\right)^2$$
$$= \frac{1}{4}\left(\frac{1}{2}mu^2\right) = \frac{E}{4}$$

10

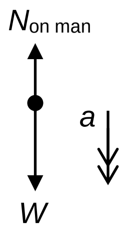


$$m_{\text{heli}}a = F_{\text{lift}} - W$$
$$= \frac{m_{\text{air}}}{t}\Delta v - m_{\text{heli}}g$$
$$m_{\text{heli}}(a+g) = \left(\frac{m_{\text{air}}}{t}\right)\Delta v$$
$$m_{\text{heli}} = \frac{\left(\frac{m_{\text{air}}}{t}\right)\Delta v}{a+g} = \frac{(2500)(15)}{12.5+9.81}$$
$$= 1680\ \text{kg}$$

11 gradient of speed-time graph should give constant acceleration thus force

12 by PCLM,

$$0 = m_{\text{cannon}}v_{\text{recoil}} + m_{\text{ball}}v_{\text{ball}}$$
$$|m_{\text{cannon}}v_{\text{recoil}}| = |m_{\text{ball}}v_{\text{ball}}|$$
$$v_{\text{ball}} = \frac{m_{\text{cannon}}}{m_{\text{ball}}}v_{\text{recoil}}$$
$$= \frac{1000}{10}(5)$$
$$= 500 \text{ m s}^{-1}$$

13 

by N3L, $N_{\text{on man}} = -N_{\text{on floor}}$ so eliminate C

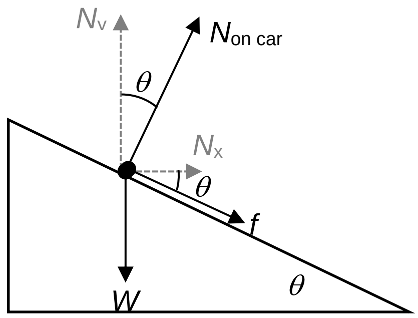
A, B) not true, from free body diagram magnitude is less than weight

14 A) work is done by gravity on the girl as she falls
B) tyres are rolling (since no skid), hence work done is done by friction on tyres.
C) work is done by the electric field of the plate against on the electron

15 efficiency is
useful power / total power expenditure

16 $v = r\omega$ so $\omega = \frac{v}{r}$

17 vector sum of normal force N and friction f provides centripetal force



horizontally:

$$f\cos\theta + N_x = \frac{mv^2}{r}$$
$$f\cos\theta + N\sin\theta = \frac{mv^2}{r}$$
$$N\sin\theta = \frac{mv^2}{r} - f\cos\theta \quad \_\_\_(1)$$

vertically $N\cos\theta = W + f\sin\theta \quad \_\_\_(2)$

$$\frac{(1)}{(2)} \text{ so } \tan\theta = \frac{\frac{mv^2}{r} - f\cos\theta}{W + f\sin\theta}$$
$$= \frac{\frac{mv^2}{r} - f\cos\theta}{mg + f\sin\theta}$$
$$\tan(30°) = \frac{\frac{1000\left(\frac{90000}{3600}\right)^2}{100} - f\cos(30°)}{1000(9.81) + f\sin(30°)}$$
$$f = 508 \text{ N}$$

18 gravitational force provides centripetal force

$$\frac{G\cancel{M}S}{R^2} = \cancel{M}R\omega^2$$
$$GS = R^3\left(\frac{2\pi}{T}\right)^2$$
$$T^2 = \left(\frac{4\pi^2}{G}\right)\left(\frac{R^3}{S}\right)$$

19 negative gradient of energy-distance graph gives force ON object; hence gradient of energy-distance graph gives force ON planet.

20

$$\phi_P = -\frac{GM}{r} = -400\times10^3 \text{ J kg}^{-1}$$

$$\phi_Q = -\frac{GM}{2r} = \frac{1}{2}\phi_P$$

$$m\Delta\phi = m\left(\phi_{final} - \phi_{final}\right)$$

$$= m\left(\phi_P - \phi_Q\right) = m\left(\phi_P - \frac{1}{2}\phi_P\right)$$

$$= \frac{m\phi_P}{2} = \frac{200\left(-400\times10^3\right)}{2}$$

$$= -40\times10^6 \text{ J kg}^{-1}$$

21 gravitational force provides centripetal force

$$\frac{GM_E \cancel{m_s}}{r^2} = \cancel{m_s} r\omega^2$$

$$r = \sqrt[3]{\frac{GM_E}{\omega^2}}$$

$$v = r\omega = \sqrt[3]{\frac{GM_E}{\omega^2}}(\omega)$$

$$= \sqrt[3]{GM_E\omega} = \sqrt[3]{GM_E\frac{2\pi}{T}}$$

$$= \sqrt[3]{\frac{\left(6.67\times10^{-11}\right)\left(6\times10^{24}\right)(2\pi)}{24\times60\times60}}$$

$$= 3080 \text{ m s}^{-1}$$

22

$$x = x_0 \sin(\omega t)$$

$$= (0.12)\sin\left(\frac{2\pi}{T}\times\frac{T}{8}\right)$$

$$= 0.085 \text{ m}$$

23 period is 0.50 s

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.50}$$

$$= 12.6 \text{ rad s}^{-1}$$

24 X and Y separated by distance of 1.5λ

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta s}{\lambda}$$

$$\Delta\phi = 2\pi\left(\frac{\Delta s}{\lambda}\right)$$

$$= 2\pi(1.5) = 3\pi = (3\times180)^\circ$$

25 Each double slit generates a single slit diffraction pattern

26 $\lambda = \frac{v}{f} = \frac{350}{50} = 7.0 \text{ m}$

(compression to compression: 1 λ)

RS $= 4\lambda = 28$ m

27 All particles in an inter-nodal segment are in-phase with each other, and are in anti-phase with particles in adjacent inter-nodal segment.

28 flight path of UAV is like a screen to two-source interference pattern. Screen distance is much larger than source separation so

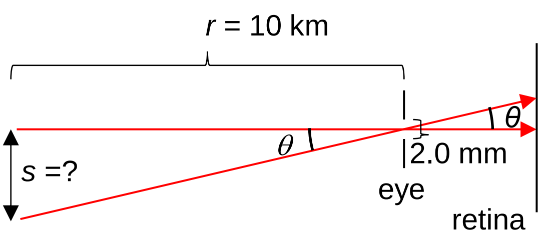
$$x = \frac{\lambda D}{a} = \frac{\left(3.0\times10^{-2}\right)(2000)}{15} = 4.0 \text{ m}$$

maxima's are every 4.0 m apart. since UAV flies are constant speed:

$$v = \frac{x}{T}$$

$$T = \frac{x}{v} = \frac{4.0}{90} = 0.044 \text{ s}$$

29



$$\frac{s}{r} = \theta \approx \frac{\lambda}{b}$$

$$s \approx \frac{r\lambda}{b}$$

min distance so shortest wavelength

$$s \approx \frac{\left(10\times10^3\right)\left(400\times10^{-9}\right)}{2.0\times10^{-3}} = 2.0 \text{ m}$$

30 $d\sin\theta = n\lambda$

$d\sin(30^\circ) = \lambda = 0.50d$

$$x = \frac{\lambda D}{a} = \frac{\left(0.50\cancel{d}\right)D}{500\cancel{d}}$$

$$= \frac{0.50(1.5)}{500} = 0.0015 \text{ m}$$