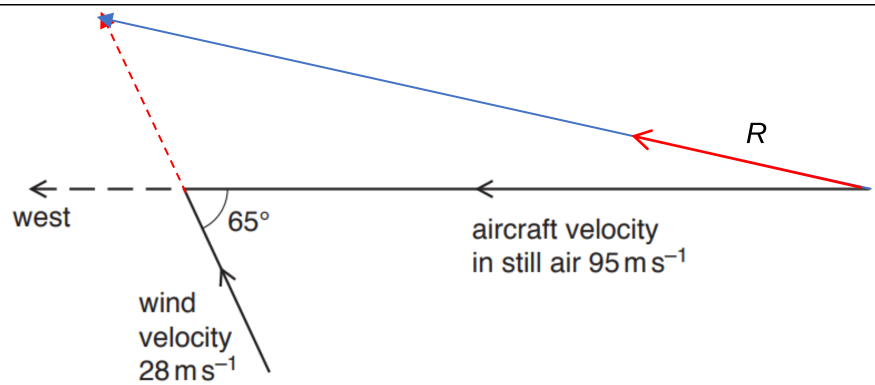
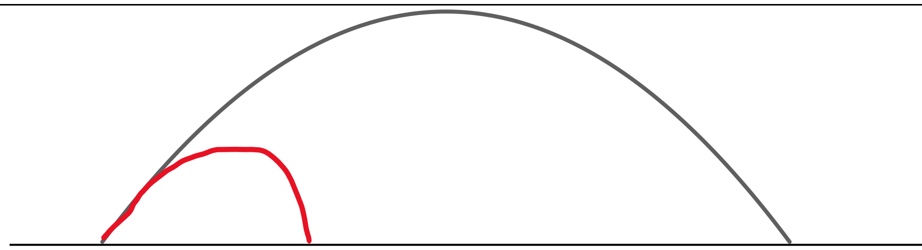
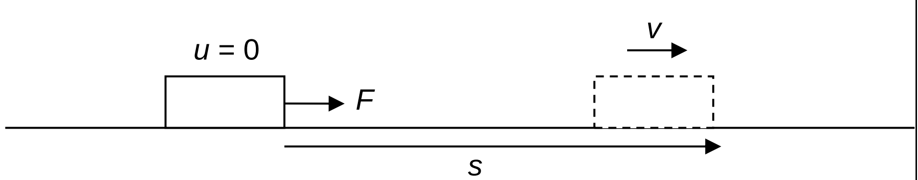
DUNMAN HIGH SCHOOL
2022 H2 PHYSICS (YEAR 5)

<u>2022 DHS H2 Physics Promo Exam Mark scheme</u>

<u>Section B Structured Questions</u>

1(a)(i)	Allow anything between 20 – 20000 Hz	B1
1(a)(ii)	Allow anything between 10 – 400 nm	B1
1(b)	A vector is a physical quantity that has both magnitude and direction.	B1
1(c)(i)	 Arrow labelled *R* in a direction ≈ 10° – 15° north of west.	B1
1(c)(ii)	$v^2 = 28^2 + 95^2 - (2 \times 28 \times 95 \times \cos 115^\circ)$ $v = 110$ m s^{-1}	C1 A1
2(a)	45°	A1
2(b)	Take up and right as positive. Horizontally, $(u \cos 45^\circ)t = 4.00 - - - - - - - - (1)$ Vertically, $(-u \sin 45^\circ) = (u \sin 45^\circ) - (9.81)(t)$ $t = (2u \sin 45^\circ)/9.81 - - - - - - - - (2)$ Sub (2) into (1) and solving, $u^2 = 39.24$ $u = 6.26$ m s^{-1}	C1 C1 A1
	Comment: It was evident that most students did not practise solving kinematics problems.	

2(c)	Using '$v^2 = u^2 + 2as$', $0 = (6.26\sin 45^o)^2 - 2(9.81)(s)$ $s = 0.999$ m	A1
2(d)	 asymmetrical shape, smaller horizontal range, and smaller maximum height.	B1
	Comment: Symmetrical shapes were drawn in most scripts.	
3(a)	$(m =)\ \rho V$ $= (1.0\times10^3)\times(1.5\times10^{-4})\times(5.0\times1.6) = 1.2$ (kg)	C1 A1
3(b)(i)	$\Delta p = m\Delta v = 1.2\times5.0$ $= 6.0$ N s	A1
3(b)(ii)	$F = 6.0/1.6$ $= 3.8$ N	A1
3(c)	By Newton's third law, the force exerted by the water on the wall is equal in magnitude (but opposite in direction) to the force exerted on the water by the wall, (so) 3.8 N.	B1
3(d)	$p = F/A = 3.8/1.5\times10^{-4} = 2.5\times10^4$ Pa	A1
3(e)	momentum change of water is equal and opposite to momentum change of the wall OR total change in momentum of water and wall is zero	B1
	Comment: The statement should refer to the specific interaction between the water and wall, instead of just stating the principal of conservation of momentum.	
4(a)	Net force in any direction is equal to zero Net torque about any axis of rotation is equal to zero	B1 B1

	Comment: Very few students stated the correct conditions. Resultant force and resultant torque were commonly written instead of net force and net torque. Zero net force and zero net torque must be clearly stated.	
4(b)(i)1.	$\cos\theta = 6.0/12.0 \rightarrow \theta = 60°$ (or other methods) Let L be the length of ladder, Taking moments about axis through lower end of ladder, $N_1 \times L \sin 60^o = (72 \times 9.81)(3L/4) \cos 60^o + (40 \times 9.81)(L/2) \cos 60^o$ $N_1 = 419$ N	 C1 A1
	Comment: Majority of students lacked the skills in resolutions of vectors, in this case, forces in the x and y direction. Wrong moments of forces were taken and equated. This part was either left totally blank or badly done.	
4(b)(i)2.	Vertically, $N_2 = (72.0 + 40.0) \times 9.81$ $= 1100$ N	 A1
	Comment: Wrong moments of forces were taken and equated, instead of equating the forces vertically.	
4(b)(ii)	magnitude of friction by ground on ladder = $N_1 = 419$ N Hence magnitude of total reaction force by ground on ladder $= \sqrt{1100^2 + 419^2} = 1180$ N	 A1
	Comment: Most often, the understanding of resultant of forces was lacking among the students in this part.	
4(b)(iii)	$\tan^{-1}(\frac{1100}{419}) = 69.1^o$ R drawn correctly at an angle of 69.1° clockwise from the horizontal.	 A1
	Comment: Only a few students could draw the correct direction of R.	
5(a)	Consider a stationary object of mass m which moves a horizontal displacement s under the action of a constant net force F.  	B1

	Since the force is constant, the object moves with a constant acceleration *a* given by Newton's second law of motion: $$F = ma$$ When the object undergoes a displacement *s*, its final velocity *v* can be found from the following equation of motion: $$v^2 = u^2 + 2as$$ or $$s = \frac{v^2}{2a}$$ since $u = 0$ The work done on the object $W = F.s$ $$= ma\left(\frac{v^2}{2a}\right)$$ $$= \frac{1}{2}mv^2$$ = kinetic energy E_k of the object. [Answers with only equations and substitutions, without physics explanations or context will score 1 mark max] **Note:** - Accept: Consider an object starting from rest and travelling with constant acceleration for a distance s. - 2nd B1 mark is only awarded if the working is logically and mathematically consistent. Students must explain in some form of another how u is eliminated from $v^2 = u^2 + 2as$ if no context was given. - Did not accept answers that states/suggests that $a = 0$. (i.e. contradictory statements such as "box is travelling at constant velocity under a force F" or workings that use $s = vt$)	B1 A0
5(b)(i)	change in GPE = $mgh_Y - mgh_X = (330)(1.1 - 4.0) = -960$ J	A1
5(b)(ii)	work done against resistive force = 960 – 540 = 420 J distance moved = 420 / 52 = 8.1 m	C1 A1
5(b)(iii)	Air resistance increases with speed / child may change body shape along the slide hence air resistance changes. **Accept also:**	B1

	- The normal force on the child changes due to the curvature of the slide, hence friction force is not constant. - Slide may be unevenly coated with water and hence friction force varies at different points of the slide **Do not accept:** - If type of force (friction or air resistance) is not identified in the answer. - Some parts of the slope are smoother than others, hence friction force is different. (Students should specify the cause of the difference in smoothness) **Common misconceptions:** - Friction increases with increasing speed - Friction increases when surface area of contact between the child and slide increases - Air resistance is directly proportional to speed/velocity - Air resistance/friction changes with acceleration	
6(a)(i)	$a = g\sin 40^{\circ} = 9.81\sin 40^{\circ}$ $= 6.31 \text{ m s}^{-2}$	A1
	Comment: Students who got wrong here were unable to resolve vectors.	
6(a)(ii)	speed of the ball at the bottom of the slope, $v = \sqrt{2as} = \sqrt{2(6.31)(0.56)}$ $= 2.66 \text{ m s}^{-1}$	A1
6(b)(i)	magnitude of centripetal force, $F = \dfrac{mv^2}{r} = \dfrac{(72\times10^{-3})(1.5)^2}{12\times10^{-2}}$ $= 1.4 \text{ N}$	C1 A1
	Comment: Mistakes were made in the conversion of units and forgot to square the speed in the calculation.	
6(b)(ii)	at the top of the loop, <u>centripetal force acting on the ball</u> is provided by the <u>sum of the force due to the track</u> and <u>the weight of the ball</u>. force due to the track acting on the ball = centripetal force – weight of the ball = 1.4 – (72 x 10^{-3}) (9.81) = 0.69 N direction of force due to the track acting on the ball: vertically downwards.	 A1 B1
	Comment: Direction of force was not properly stated clearly.	
7(a)	<u>direction of force</u> on a (small test) <u>mass</u> OR	B1

<table>
<tr><td></td><td>path in which a (small test) mass will move

Accept:
Line of action of force on a (small test) mass.

Do not accept if students wrote:
- Direction of force on an object OR path in which an object will move.
(Students must define “line of gravitational force” in relation to the physical quantity of mass)
- Direction of gravitational field strength on a mass</td><td></td></tr>
<tr><td>7(b)</td><td>(at surface,) lines (of force) are radial
Earth has large radius / height above surface is small so lines are (approximately) parallel
and equally spaced

Accept:
- Lines of gravitational force are directed towards the centre of the earth
- Lines act in (approximately) the same direction

Do not accept if students wrote:
- The lines of gravitational field are (approximately) uniform
- The lines of gravitational field are close to one another</td><td>B1

B1
B1</td></tr>
<tr><td>8(a)</td><td>An ideal gas is a hypothetical gas that obeys the equation of state (pV = nRT) perfectly for all pressure p, volume V, amount of substance n and temperature T.

Accept (due to errata in notes):
An ideal gas is a hypothetical gas that obeys the equation of state (pV = nRT) perfectly for all pressure p, volume V, and temperature T.
(i.e. all else the same, just missing “amount of substance n”)</td><td>B1</td></tr>
<tr><td>8(b)</td><td>$pV = \frac{1}{3}Nm \langle c^2 \rangle$
$= \frac{1}{3}m_{gas} \langle c^2 \rangle$
$c_{r.m.s.} = \sqrt{\frac{3pV}{m_{gas}}}$
$= \sqrt{\frac{3(10\times10^5)(3\times10^{-3})}{0.004}}$
$= 1500\,\text{m s}^{-1}$

Note:
1st mark is awarded for demonstrating an understanding that $Nm = m_{gas}$</td><td>C1

C1
A1</td></tr>
</table>

	Do not accept: If working suggests that students assumed $n=1$ OR $N=1$ even if final answer is correct.	
8(c)(i)	$W_{ON} = -p\Delta V$ $= -p(V_f - V_i)$ $= -2.5\times10^5(3.0\times10^{-3} - 8.0\times10^{-3})$ $= 1250\text{ J}$	A1
8(c)(ii)	For an ideal gas, PE = 0. Therefore, $\Delta U = KE_{total}$ $= \Delta(\frac{3}{2}pV)$ $= \frac{3}{2}V\Delta p$ $= \frac{3}{2}(3.0\times10^{-3})(10.0\times10^5 - 2.5\times10^5)$ $= 3375\text{ J}$	C1 A1
8(d)	(see table below)	B1 B1 B1
9(a)	A, g and ρ all constant so $F \propto x$	B1
	minus sign means F and x are in opposite directions	B1
	Comment: Many candidates did not provide qualitative explanation.	
9(b)	$a = \frac{F}{m}$ so $a = -\frac{Ag\rho x}{m}$	M1
	so $\omega^2 = \frac{Ag\rho}{m}$ hence $\omega = \sqrt{\frac{Ag\rho}{m}}$	A1

8(d):

Section of cycle	Heat supplied to the gas / J	Work done on the gas / J	Increase in internal energy of gas / J	
A → B	2940	-2940	0	B1
B → C	-4625 (ecf if $Q+W=\Delta U$)	1250 (ecf 8ci)	-3375 (ecf if $\Delta U_{A\to B} = \pm 2940$ or 0 and $\sum \Delta U = 0$)	B1
C → A	3375 (ecf 8ci)	0	3375 (ecf 8cii)	B1

9(c)	damping due to viscous forces	B1
9(d)	$E = \frac{1}{2} m\omega^2 x_0^2$	C1
	$\omega^2 = -$ gradient	C1
	$\Delta E = \frac{1}{2} m\omega^2 \left[(x_0)_i^2 - (x_0)_f^2 \right]$ $= \frac{1}{2}(0.57)\dfrac{2.3}{0.020}(0.020^2 - 0.016^2)$ $= 4.7 \times 10^{-3}$ J	A1
	Comment: ω^2 should be the same value for both positive and negative x in Fig. 9.3, which is a straight line passing through the origin.	