DUNMAN HIGH SCHOOL 2020
PHYSICS H2 (YEAR 5)

Answers to Promo Exam

MCQ

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
D	**B**	**D**	**D**	**C**	**D**	**D**	**C**	**B**	**A**
Q11	Q12	Q13	Q14	Q15					
D	**A**	**B**	**B**	**B**					

Structured Questions

1(a) 2 of the following:
-temperature, kelvin
-current, ampere
-amount of substance, mole
-luminous intensity, candela
1 mark for each correct quantity and unit, correctly spelled (no caps). [2]

MC: It is surprising that more than half the cohort cannot remember the SI base quantities and units. Some students didn't write in words, instead using only symbols hence no credit. Lastly, for units, the spelling should be all small letters, i.e. kelvin instead of Kelvin. This point wasn't penalized for this exam, but please remember next time.

(b) units of E: kg m^2 s^{-2} , units of ρ: kg m^{-3} , units of g: m s^{-2}, units of A: m^2, units of L: m C1
units of C: kg m^2 s^{-2} / kg^2 m^{-6} m^2 s^{-4} m^2 m^3 C1
= kg^{-1} m s^2 A1 [3]

MC: Some students left answers in J or N, which are not base units.

(c) radius = (10.0 ± 0.1) mm
Volume V = $\pi r^2 h$

= $\pi (10)^2 (1.5)$

= 471.2 mm^3 --- (M1)

$\Delta V / V = 2\Delta r / r + \Delta h / h$

$\Delta V = (2\Delta r / r + \Delta h / h) V$

= [2(0.1/10) + (0.1/1.5)](471.2)

= (0.02 + 0.067) (471.2)

= 40 mm^3 (1 s.f) --- (M1)

Therefore V = (470 ± 40) mm^3 --- (A1) [3]

MC: Many students left answer as (471 ± 40) mm^3. This is a misconception. Note that the uncertainty is in the "tens" decimal position, hence the quantity should be also rounded to the same decimal position i.e. "tens" position.

2 **(a)** Use of $mgh = ½\, m\, v^2$ C1
h = 14.7 or 15 m A1

(b) **(i)** $v_Y = u_y + a_y t$

$= 0 + (9.81)\ (1.6)$ C1

$= 15.7$ or 16 m s^{-1} A1

(ii) Straight line of positive gradient B1

Starting at 0 m s^{-1} and ends at 16 m s^{-1} at 1.6 s. B1

(iii) resultant $v^2 = 15.7^2 + 17^2$ C1

v = 23 or 23.1 m s^{-1} A1

MC : Majority of candidates did well in this question. A few used the slope angle to calculate the vertical component of velocity at C which was incorrect.

Q3 MC For similar questions, refer to

- 2019 DHS Promo Structured Question 2
- 2020 DHS Dynamics Lecture Example 13
- 2015 A-level H1 Q7
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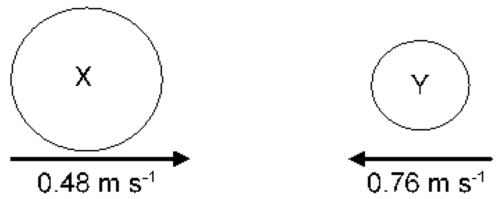
3(a) 0.76 + 0.48 = 1.24 m s^{-1} **A1**

(b) 1.24 m s^{-1} **A1**

MC For e.c.f, ans should be identical to **(a)**

(c) Before collision,



After collision,

C1

By conservation of linear momentum,

$5.2(0.48) - 2.3(0.76) = 5.2V_X + 2.3V_Y = 0.748$ --- (1) **C1**

Using law of restitution,

$1.24 = V_Y - V_X$ --- (2)

Solving, **A1**

$V_X = -0.281 \text{ m s}^{-1}$

$V_Y = 0.959 \text{ m s}^{-1}$

<u>MC</u> Momentum is a vector;

The conservation of kinetic energy equation i.e.

$$\frac{1}{2}(5.2)V_X{}^2 + \frac{1}{2}(2.3)V_Y{}^2 = \frac{1}{2}(5.2)(0.48)^2 + \frac{1}{2}(2.3)(0.76)^2$$

$(5.2)V_X{}^2 + (2.3)V_Y{}^2 = 2.52656$ --- (3)

is acceptable for C1

However, it is more difficult to solve equations (1) and (3) compared to equations (1) and (2).

The other possible answer from equations (1) and (3) is $V_X = 0.48 \text{ m s}^{-1}$ & $V_Y = -0.76 \text{ m s}^{-1}$, which is physically impossible, because it is as if X and Y never collide, and has to be rejected.

(d) Change in momentum of X, Δp_X = **M1**

$(5.2)(-0.281)-(5.2)(0.48)\approx -3.96$ kg m s^{-1} **A1**

MC Candidates should use physical quantities related to X for calculation.

Change of a physical quantity = **final** physical quantity **–** **initial** physical quantity.

(e) 3.96 kg m s^{-1} **A1**

MC $\Delta p_Y = F_{XY}\Delta t = -F_{YX}\Delta t = -\Delta p_Y$

4(a) Boat has **greater volume compared to solid block** (more empty space within). **B1**

Hence, it **displaces more water** and can achieve sufficient upthrust to support its weight. **B1**

OR

Combined density of reshaped clay and enclosed air is

less than density of **water**

MC Common **misconception(s)**:

- justification using **surface area**
- state **cause** of upthrust
- failure to relate to **context** of question and state in general why a solid object floats on a liquid using principle of floatation i.e. weight of object = upthrust; candidates are expected to compare the situations of the clay block and clay boat
- **confusion between clay block and clay boat** e.g. stating volume of water displaced is more than volume of clay boat, and not clay block.

4(b)(i) $T = W = mg = 0.200(9.81) = 1.96$ N **A1**

MC - 4.s.f acceptable due to ambiguity of 200 g.

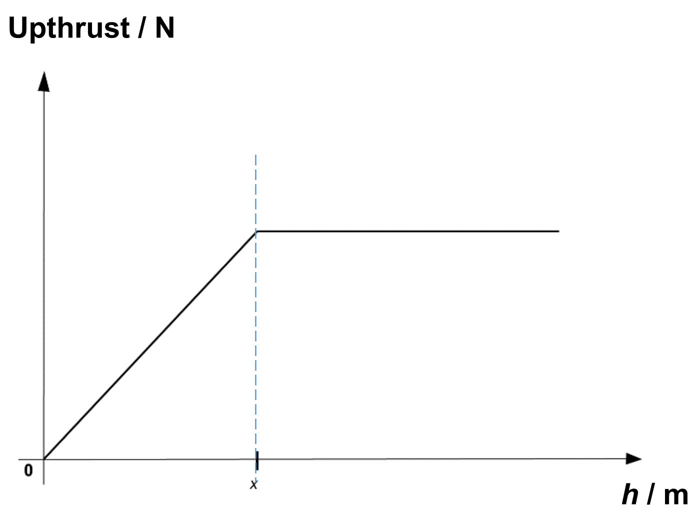
4(b)(ii) $V = \frac{m}{\rho} = \frac{0.200}{8000} = 2.5 \times 10^{-5}\ \text{m}^3$ **A1**

4(b)(iii) $T + U = W$

$T = W - U$

$T = 1.96 - (2.5 \times 10^{-5})(800)(9.81) = 1.76\ \text{N}$ **A1**

4(c)



B1: Constant gradient up till *h* = *x*

B1: no increase thereafter

MC Candidates should relate upthrust to volume of fluid displaced;

once the object is fully submerged, the volume of fluid displaced is equal to the volume of the object.

5(a)

v / m s^{-1}	R / N	F / N	Total Resistance F_T/ N	Power Required / kW
9.0	228	52	280	2.5
18	223	206	429	7.7
27	219	470	689	18.6

A1

MC

- $F_T = F + R$
- Power required in kW = $F_T v$ / 1000

(b) F_T = 220 + ½(0.995) (1.29)(32)^2 **C1**

= 877 N **A1**

(c)(i) Power supplied by engine = 102 x 0.746 = 76.1 kW **A1**

(c)(ii) Power required < power supplied by engine due to **energy loss** **B1**

(Loss could be due to other energy uses in the car such as **radiator, headlights, air-conditioner, radio or other internal frictional forces in the car along the transmission line from engine to the wheels. /Thermal energy produced by engine**.)

MC Difference in **power required in Fig. 5.1** and **power supplied by engine in (c)(i)** for $v = 45$ m s^{-1} is

76.1 - 67.7 = 8.4 kW

which is ~11% of power supplied of engine and thus it is significant.

In **Fig. 5.1**, power required already take into account total resistance i.e. air resistance F + friction with road R

"… the car is travelling at maximum speed on **a level** road."

6 (a) (i) $\omega = \dfrac{2\pi}{2.33 \times 10^6}$ C1

$= 2.69 \times 10^{-6}$ rad s^{-1} A1

(ii) $a = r\,\omega^2$

$= (3.82 \times 10^8)(2.69 \times 10^{-6})$ C1

$= 2.76 \times 10^{-3}$ m s^{-2} A1

(iii) $F = ma$

$= (7.35 \times 10^{22})(2.76 \times 10^{-3})$

$= 2.03 \times 10^{20}$ N A1

MC : Majority of candidates did well in this part.

A few used the formula for gravitational force of attraction to calculate (a)(iii). No credit given as there was no data on the mass of Earth in the question.

(b) **Acceleration** is directed **towards the centre** [B1] and thus it always **perpendicular to velocity** [B1], hence it does not change the magnitude of the velocity (i.e. speed).

MC : A few candidates mentioned “acceleration is perpendicular to the direction of speed” which was wrong as speed was not a vector.

Majority of candidates obtained 1 out of 2 marks.

(c)(i) Potential at infinity is taken to be zero. [B1]
Due to the **attractive nature** of the gravitational force, work done by an external force to bring any mass from infinity to that point is always negative. [B1]
Hence the potential at any point must always be negative.

MC : Majority of candidates just stated the definition of gravitational potential without explaining or just quoted that since potential at infinity is zero, potential at other points will be negative since zero is the maximum value. No mention of the attractive nature of the gravitational field to relate it to the work done in the definition.

(ii) $\Delta\phi = \phi_f - \phi_i$

$$= -GM\left[\left(\frac{1}{r_f}\right)-\left(\frac{1}{r_i}\right)\right]$$

$$= -(6.67 \times 10^{-11})(6.0 \times 10^{24})\left[\frac{1}{(6.4\times10^{6}+1.3\times10^{7})}-\left(\frac{1}{6.4\times10^{6}}\right)\right] \quad \text{[C1]}$$

$= 4.19 \times 10^{7}$ J kg^{-1} [A1]

MC : Common mistakes such as converting km to m, change in potential was calculated using initial potential minus final potential were made in this part.

7(a) An oscillatory motion of a particle whose <u>acceleration is directly proportional to its displacement from a fixed point [B1]</u> and this <u>acceleration is always in opposite direction to its displacement [B1].</u>

MC: For definition, only this is accepted.

(b)(i) mg = ke

k = mg/e = (0.400 x 9.81)/(0.200) = 19.6 N m^{-1} [A1]

(ii) $\omega = 2\pi / T$ [C1]

$$= \sqrt{\frac{k}{m}}$$

$$= \sqrt{\frac{19.62}{0.400}} = 7.00 \text{ rad s}^{-1}$$ [A1]

(iii) $v_{max} = \omega X_0 = (7.00)(0.200) = 1.400 \text{ m s}^{-1}$ [C1]

$KE_{max} = ½\, m\, v_{max}^2 = ½\,(0.400)(1.400)^2 = 0.392 \text{ J}$ [A1]

(iv) $v = \pm\omega\sqrt{x_o^2 - x^2} = (7.00)\sqrt{(0.200)^2 - (-0.100)^2} = 0.173 \text{ m s}^{-1}$ [A1]

(c) At the bottom of the oscillation, the gravitational potential energy of the system is at a minimum while its elastic potential energy is at a maximum. The kinetic energy is zero. [B1]

As the mass moves upwards towards the equilibrium point, elastic potential energy is converted into gravitational potential energy and kinetic energy. (EPE decreases while KE and GPE increases) [B1]

As it continues to move upwards above the equilibrium point, kinetic and elastic potential energy of the system is converted into gravitational potential energy. [EPE and KE decreases while GPE increases] [B1]

At the top of the oscillation, the system has its maximum gravitational potential energy and zero elastic potential energy and zero kinetic energy. [B1]

<u>MC:</u> There are a number of candidates who had the misconception that the spring will compress. But note that at the top of the oscillation, the spring is only at its unstretched length.

Also, there's a number of students who were unclear about which potential energy they are referring to. Note that it is important to discuss Gravitational PE and Elastic PE separately instead of lump them together.