DUNMAN HIGH SCHOOL
2019 YEAR 5 H2 PHYSICS

Answers to Promo Exam

MCQ

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
B	**A**	**B**	**D**	**A**	**D**	**C**	**B**	**C**	**D**
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
C	**C**	**C**	**A**	**D**	**B**	**B**	**D**	**A**	**D**

Structured Questions

1 **(a)** Speed decreases/ stone decelerates to rest/zero at 1.25 s.
Speed then increases/ stone accelerates in opposite direction.

Marker's comments: From the description, some students demonstrate poor understanding of the motion, mistakenly thinking that as the gradient is positive, velocity is increasing and velocity is decreasing when gradient is negative. There were also some mistakes in reading the time the stone reaches highest displacement.

(b) **(i)** $v = u + at$

$= 0 + (9.81)(3.0 – 1.25)$

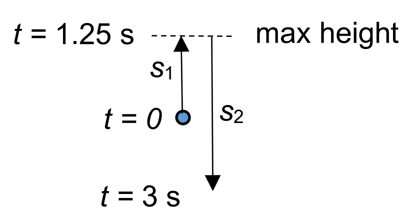
$= 17.2 \text{ m s}^{-1}$

Marker's comments: There were many wrong answers that substitute $u = 0$ with $t = 3$ s in the given equation. In addition, it is not possible to calculate the velocity from the gradient as numerical values for the displacement are not given.

(ii) $s_1 = \frac{1}{2}at^2 = \frac{1}{2}(9.81)(1.25)^2 = 7.66 \text{ m}$

$s_2 = \frac{1}{2}at^2 = \frac{1}{2}(9.81)(1.75)^2 = 15 \text{ m}$

total distance = 7.66 + 15 = 22.7 m



Marker's comments: Another method is to find the initial upward speed at $t = 0$ = the downward speed at $t = 2.5$ s = 12.3 m s^{-1}. A shorter method is to use the above.

(iii) displacement = $s_2 - s_1$

$= 7.34 \text{ m}$

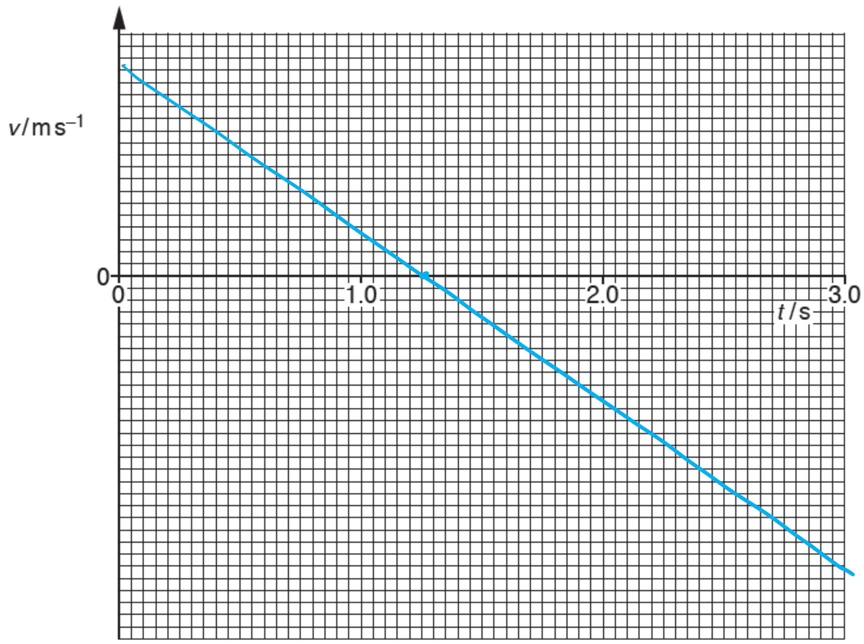
direction: downward

Marker's comments: Using the alternative method in (ii), the answer can be found by substituting $u = 12.3 \text{ m s}^{-1}$ and $t = 0.5$ s into the equation for displacement with uniform acceleration.

(c) straight line with negative gradient, positive value of v from $t = 0$ to $t = 1.25$ s

negative values of v from $t = 1.25$ s to $t = 3.0$ s, same gradient

Note: acceptable range for horizontal intercept: 1.2 to 1.3



Marker's comments: Some students overlooked that in (b), the question already mentioned air resistance is negligible. Hence there is only acceleration due to free fall which is constant. The direction of acceleration is downwards, hence the gradient of the line is negative.

2 **(a)** The total momentum of a system of bodies is constant, provided no external resultant force acts on the system.

Marker's comments: Some students attempted to explain the answer by using formula instead. In addition, there were also some students who provided the definition for principle of moments.

(b) Taking rightwards as positive,

By principle of conservation of momentum,

$$m_A u_A + m_B u_B = m_A V_A + m_B V_B$$

$$(0.50)(2.0) + (0.30)(-2.0) = (0.50)V_A + (0.30)V_B$$

$$0.4 = (0.50)V_A + (0.30)V_B \quad \text{------------------- (1)}$$

Relative speed of approach = relative speed of separation,

$$u_A - u_B = V_B - V_A$$

$$2.0 - (-2.0) = V_B - V_A$$

$4.0 = V_B - V_A$ ------------------ (2)

Solving equations (1) and (2),

V_A = -1.0 m s^{-1}

V_B = 3.0 m s^{-1}

Marker's comments: Many students did not adopt a sign convention in this part of question. As a result, the answers did not reflect accurately the direction of motion of the boxes. Students were encouraged to explain clearly how the boxes moved after collision.

(c) **(i)** $m_A u_A + m_B u_B = (m_A + m_B) v_f$

$$v_f = \frac{(0.50)(2.0)+(0.30)(-2.0)}{(0.50+0.30)}$$

= 0.5 m s^{-1}

Marker's comments: Some students wrongly assumed the collision to be elastic and attempted to solve by applying the law of conservation of kinetic energy.

(ii) During the collision, force on box A and box B is the same but box A has a greater mass.

Hence, acceleration of box A is smaller.

Marker's comments: An acceptable alternative method is to consider the change in velocity of both boxes and deduce the acceleration based on the rate of change of velocity of each box.

(iii) $KE_i = \frac{1}{2}(0.50)(2)^2 + \frac{1}{2}(0.30)(-2)^2 = 1.6\ J$

$$KE_f = \frac{1}{2}(0.50+0.30)(0.5)^2 = 0.1\ J$$

$$\frac{KE_f}{KE_i} = \frac{0.1}{1.6} = 0.063$$

Marker's comments: Some students substituted -1.0 m s^{-1} and 3.0 m s^{-1} as the final velocities of box A and box B instead. There were also students who found $\frac{KE_i}{KE_f}$.

3 **(a)** weight = mass x g = density x volume x g

$$= \rho\left(\frac{\pi d^2}{4}h\right)g$$

$$= 2700\,\frac{\pi(0.024)^2}{4}(0.05)(9.81)$$

= 0.599 (must be seen)

= 0.60 N (must end with value asked to show)

Marker's comments: For "show" kind of question, all explanations, including substitutions of intermediate and final values in the calculations must be seen.

(b) **(i)** At equilibrium, the <u>sum of</u> forces in any direction is zero.
The <u>sum of</u> moments about any point is zero.

Marker's comments: There is no reason not to obtain full marks for this kind of equation.

(ii) clockwise moment about pivot = anti-clockwise moment about pivot

$$12W = (0.25 \times 8) + (0.60 \times 38)$$

$$W = 2.1\ \text{N}$$

Marker's comments: There were some careless mistakes in obtaining the correct distance to calculate the anti-clockwise moments.

(c) **(i)** pressure on bottom of <u>greater than</u> pressure on top or force on bottom <u>greater than</u> force on top

Marker's comments: Many students did not understand the meaning of the word "origin". To attribute upthrust to difference in pressure is not specific enough.

(ii) <u>anti-clockwise</u> moment reduced and reducing weight of X reduces <u>clockwise</u> moment

Marker's comments: It is wrong to explain that upthrust contribute clockwise moments. Upthrust acts on the cylinder which is in equilibrium. However, the question asked how about equilibrium of the bar. Some students even mistakenly thought upthrust reduces the weight of cylinder!

(iii) clockwise moment about pivot = anti-clockwise moment about pivot

$$12W = (0.25 \times 8) + \left[38 \times \left(0.60 - \frac{\pi(0.024)^2}{4}(0.05)(1260)(9.81)\right)\right]$$

$$W = 1.2\ \text{N}$$

Marker's comments: Some students did not using the density of liquid to calculate the upthrust. Some answers did not take the resultant downward force at A to calculate the anti-clockwise moment.

4 **(a)** **(i)** any **three** from
- (speed is constant but) direction is continuously changing (towards centre)
- (velocity is changing) with time (so body accelerates)
- by Newton's 2nd law
- a force is required (for acceleration towards centre)

(ii) $a = v^2/r$

(b) $R - mg = mv^2/r$ or $R = 200 + [(20/9.81)^2 \times 4.7^2]/2.8 = 200 + 161$
$R = 361$ N

(c) any **three** from
- statement of Newton's first law;
- (hence) without car wall/restraint/friction at seat, the people in the car would move in a straight line/at a tangent to circle;
- (hence) door/seat belt/seat exerts centripetal force;
- (in frame of reference of the people) straight ahead movement is interpreted as "outwards"

Comments: (a) (i) Many did not explain that the direction of motion is changing steadily with time. (ii) A few included the mass m when stating the expression for a. (b) The main error was to write the equation as $R = mv^2/r$ or $mg - R = mv^2/r$. (c) Some did not refer to "constant velocity" when stating Newton's first law.

5 **(a)** **(i)** The mutual force of attraction between any two point masses is directly proportional to the product of the masses and inversely proportional to the square of their separation, and it acts along the line joining the two point masses.

Marker's comments: Some students merely provided the equation instead of explaining the law itself.

(ii) Gravitational field strength g is the gravitational force per unit mass experienced by a small test mass placed at that point.

$$g = \frac{F}{m} = \frac{\frac{GMm}{r_E^{\,2}}}{m}$$

$$= \frac{GM}{r_E^{\,2}}$$

Marker's comments: Students were expected to derive, and not just quote the equation. In addition, many students did not explain clearly the relationship between gravitational force and gravitational field strength.

(b) Gravitational force provides the centripetal force.

$$\frac{GMm}{R^2} = mR\omega^2 \text{ -------------- (1)}$$

Since $\frac{GM}{{r_E}^2} = 9.81$,

$$GM = 9.81{r_E}^2 \text{ -------------- (2)}$$

Substitute equation (2) into (1),

$$\frac{9.81{r_E}^2}{R^3} = \left(\frac{2\pi}{T}\right)^2$$

$$R^3 = \frac{9.81{r_E}^2}{4\pi^2}(T)^2$$

$$R^3 = \frac{9.81{r_E}^2}{4\pi^2}(24 \times 60 \times 60)^2$$

$$R = 1230{r_E}^{\frac{2}{3}}$$

Marker's comments: Students were encouraged to explain their working clearly. Some students wrongly assumed the period of satellite as one year. Many students were not able to make use of g = 9.81 m s^{-2} at surface of Earth to solve this part of question.

(c) $v \;\alpha\; \frac{1}{\sqrt{R}}$

When *R* increases, *v* decreases. Statement is therefore incorrect.

Marker's comments: Many students did not realize that there was only one particular value for the geostationary radius of the satellite. In addition, at a larger radius, the kinetic energy of satellite would have decreased.

(d) The Earth rotates from west to east.
The satellite would have the highest linear velocity due to the rotation of Earth at the equator. Hence less additional energy is required to launch the satellite into the required orbit.

Marker's comments: Many students assumed the satellite to be geostationary, and therefore discussed about the various applications of a geostationary satellite instead.

6 **(a)** region where charge experiences an (electric) force

(b) graph:

- field strength zero from $x = 0$ to $x = R$
- curve with negative gradient, decreasing from $x = R$ to $x = 3R$
- line passes through field strength E at $x = R$,
- line passes through field strength $0.25E$ at $x = 2R$ and field strength $0.11E$ at $x = 3R$

(c) **(i)** field strength $= Q / 4\pi\epsilon_0 R^2$

$2.0 \times 10^6 = Q / (4 \times \pi \times 8.85 \times 10^{-12} \times 0.26^2)$

$Q = 1.5 \times 10^{-5}$ C

(ii) electric potential $= Q / 4\pi\epsilon_0 R$

$= (1.5 \times 10^{-5}\ \text{C}) / (4 \times \pi \times 8.85 \times 10^{-12} \times 0.26)$

$= 5.2 \times 10^5$ V

Marker's comments: (a) Some did not read the question carefully and defined electric field strength instead. (b) Many either draw 1.00E or did not draw zero electric field strength from x = 0 to x = R. Some did not draw line to pass through the correct field strengths (based on invers-square law) at x = 2R and at x = 3R. (c) The majority arrived at the correct answers; there were a significant number of power of ten errors. Some did not square the radius R for (i).

7(a) straight line graph with negative gradient passing through the origin.

Marker's comments: There are a large number of candidates who did not read the question carefully and did not answer based on "features of the graph".

(b)(i) $T = \dfrac{1}{f} = 2\pi\sqrt{\dfrac{M}{k}}$

$= 2\pi\sqrt{\dfrac{0.450}{3.2}}$ (Note : k should be converted to = 3.2 N m^{-1})

$= 2.36$ s

Marker's comments: About half the number of candidates obtained full credits for this part. The rest of the candidates lose marks due to conversion of units. A small minority of candidates lose marks due to the pressing of the calculator. Please note the some calculator (especially GC) will interpret "1/2π" with "1 divide by 2 and then multiply the result by π". These candidates should check their calculator and add brackets when pressing the calculator to get "1/(2π)".

(ii) $v = \pm\omega\sqrt{x_0^2 - x^2}$

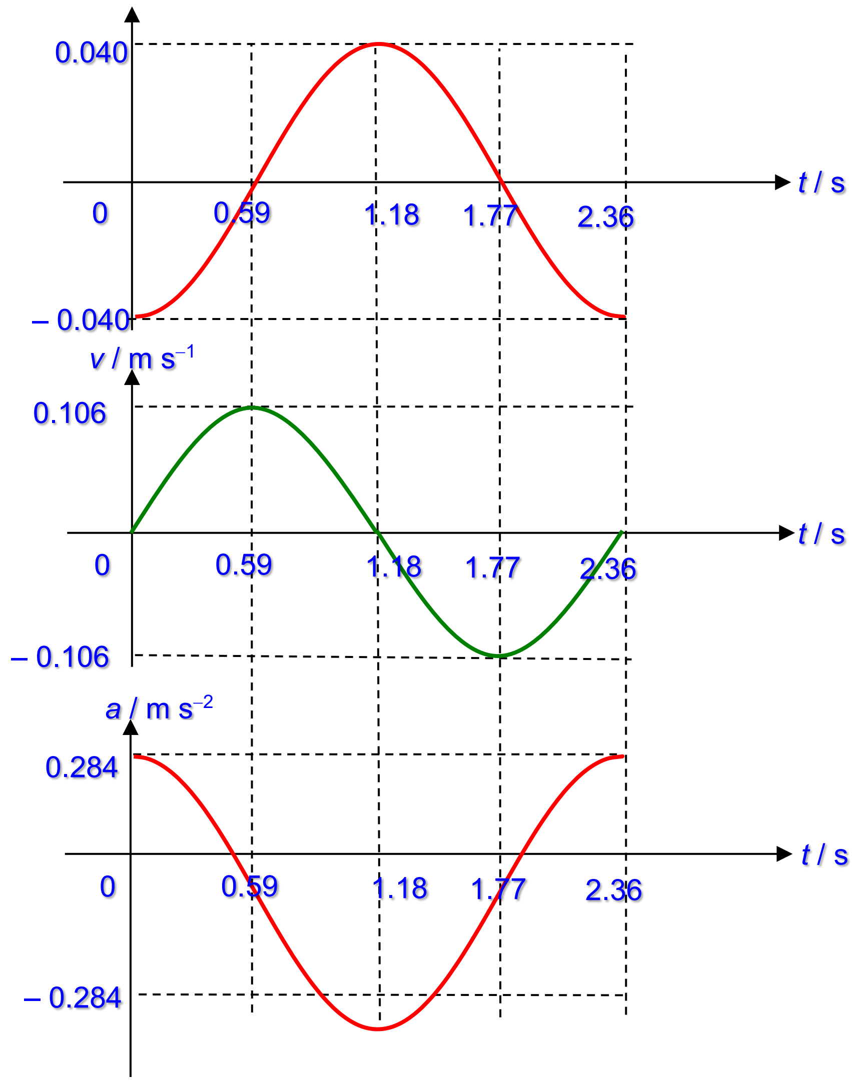
$= \pm\left(\dfrac{2\pi}{2.36}\right)\sqrt{0.040^2 - 0.030^2}$

$= \pm 0.0704$ m s^{-1}

speed = 0.0704 m s^{-1}

Marker's comments: About one-third of the number of candidates obtained full credits for this part. The rest of the candidates lose marks due to not reading the question carefully. The question asks for "1.0 cm above the lowest point". A number of candidates attempted to use conservation of energy but they confused extension with displacement when calculating elastic potential energy.

(iii)

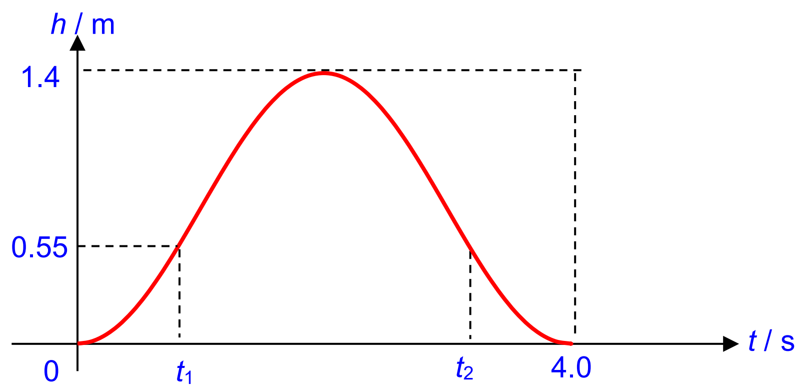


Marker's comments: This question is generally well answered. Some candidates lose marks due to not reading the question carefully and did not realise the mass starts oscillating from the bottom at t = 0. Some candidates did not answer according to the units given in the axis. A minority of the candidates thought that the velocity calculated in (b)(ii) is the maximum velocity. Error-carried-forward saved the day for majority of the candidates.

(c) (i) amplitude $= (2.20 - 0.8)/2$
$= 0.70$ m

Marker's comments: Majority of the candidates obtain full credits. Some candidates did not take into account the vertical width of the blade. A number of candidate who gave "0.7 m" got penalized one mark for significant figure. This is because the raw data given has the minimum of 2 s.f., thus the final answer should be 2 s.f. (Note: 3 s.f. is also accepted).

(ii) Taking the ground as the reference level, the graph of the variation with time *t* of the height *h* of the *bottom edge* of the blade above the ground for one cycle is shown. Assume at time $t = 0$, the blade is at its lowest position, moving upwards.



$$h = -x_o \cos \omega t + 0.7$$
$$= -0.7 \cos \frac{2\pi}{4} t + 0.7$$

For $h = 0.55$ m, $\quad 0.55 = -0.7 \cos \frac{2\pi}{4} t + 0.7$

$$\cos \frac{2\pi}{4} t = \frac{0.15}{0.7}$$

$\frac{2\pi}{4} t_1 = 1.35 \quad \Rightarrow \quad t_1 = 0.859$ s

By symmetry $\quad t_2 = 4.0 - 0.859 = 3.1$ s

duration for him to roll over $= 3.1 - 0.859 = 2.2$ s
(duration when $h > 0.55$ m)

Marker's comments: This part proved to be challenging. Only a small minority of the candidates obtain full credits. Some candidates thought that the blade moves with constant speed.