2017 Sec 3 Advanced Physics EOY Examination Answers

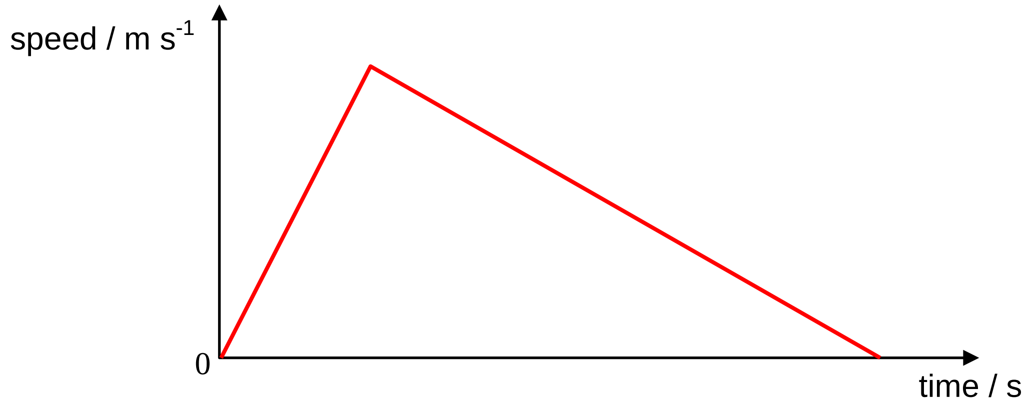
Paper 1 (30 marks) Questions for AP: Q 10, 11, 12, 15 & 16

1 …… 5	**6 ….. 10**	**11 ….15**	**16 ….20**	**21 ….25**	**26 ….30**
CBDCA	**ACCAB**	**CDBBD**	**CAACD**	**BBBAD**	**CBDDC**

Paper 2 Section A (40 marks)

1(a) $v^2 = u^2 + 2as$ ➔ $v = \sqrt{[0^2 + 2(35)(0.70)]}$
$= 7.0$ m s^{-1} (2 s.f.)

(b) 1st section: straight line from zero
2nd section: straight line back to zero (with smaller gradient)



2(a)
From t = 0 and t = 0.8 hour, the helicopter travels at uniform speed of 75 m s^{-1}.
From t = 0.8 hour to t = 0.9 hour, it decelerates uniformly to rest in air.

It then hovers (remains at rest) in the air from t = 0.9 hour to t = 1.6 hour (to rescue people).

From t = 1.6 hour to t = 1.7 hour, it accelerates uniformly in a direction opposite to its initial flying direction. Its speed increases from 0 to 90 m s^{-1}.
From t = 1.7 hour to t = 2.5 hour, it flies with a uniform speed of 90 m s^{-1}.

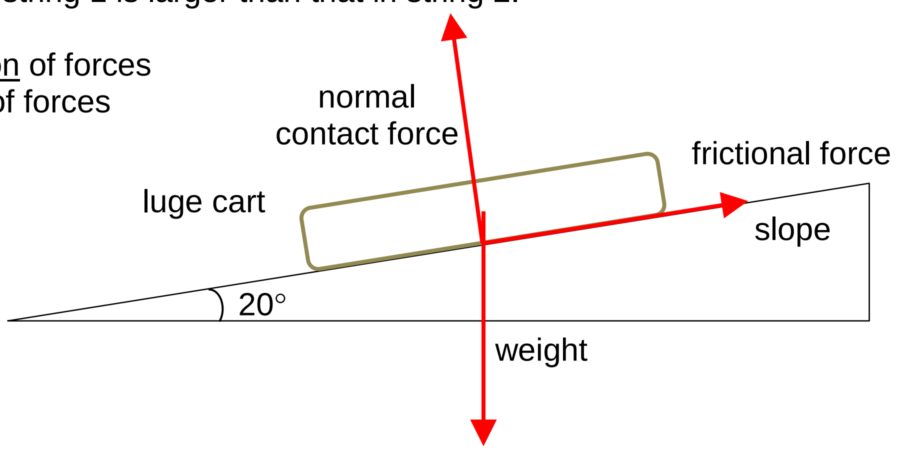
(b) Displacement = area under graph $= \frac{1}{2} \times 3600 \times [(0.8 + 0.9) \times 75]$
$= 229\,500 \approx 230$ km (2 s.f.)

3(a) $F_{net} = ma$ ➔ $a = F_{net} / m$ $= 20 / (24 + 14 + 12)$
$= 0.40$ m s^{-2} (2 s.f.)

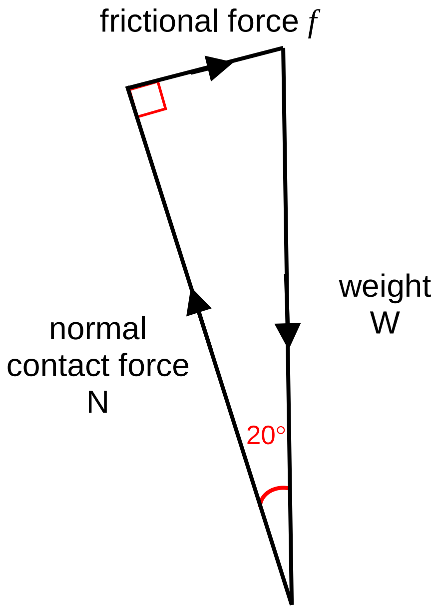
(b) 12 kg block: $F_{net} = ma$ ➔ $20 - T = 12(0.40)$
$T = 15.2 \approx 15$ N (2 s.f.)

(c) 14 kg block: $F_{net} = ma$ ➔ $T = 24(0.4) = 9.6$ N
The tension in string 1 is larger than that in string 2.

4(a) correct direction of forces
correct name of forces



(b) The component of the weight down the slope causes the luge cart to move down the slope.

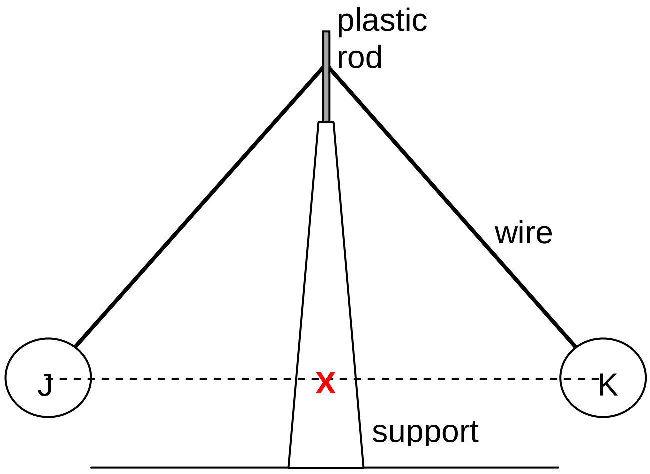


(c) correct orientation of forces
correct directions shown by arrows
angle 20° not required

(d) f / W = sin 20°
➔ f = mg × sin 20° (or mg × cos 70°)
= 25 × 10 × sin 20° = 85.51 ≈ 86 N

5(a) It is a point where the entire weight of an object appears to act.

(b) correct c.g.



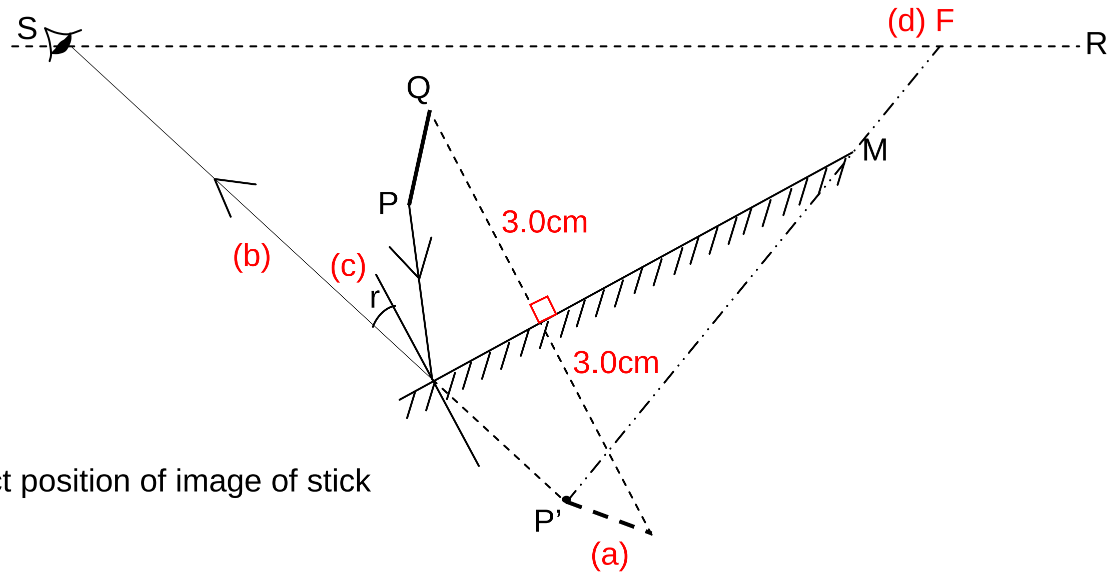
(c) When K is pushed, the c.g. moves to the left of the support.
The weight of the toy then sets up an anti-clockwise moment (which returns K to the right).

6(a) 1. It is incompressible / It has a constant density/volume.
2. It transmits pressure equally in all directions.

(b) P = F/A = 155 000 N / 13.0 m^2
= 11900 Pa or 1.19×10^4 Pa or 11.9 kPa

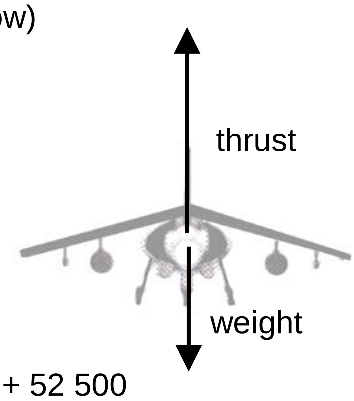
7(a) Energy cannot be destroyed or created, but only changed from one form to another.
(b) Electrical energy is converted to kinetic energy to gravitational potential energy.
(c) (i) Gain in g.p.e. = mgh = 1250 x 10 x 380
= 4.75×10^6 J or 4750 kJ
(ii) Power = gain in g.p.e. / t = 4.75×10^6 J / 25 s = 1.90×10^5 W or 190 kW
(d) Some energy is used to overcome friction and lost as thermal energy to the surroundings. / Some energy is lost as sound produced in the motor to the surroundings.

8



(a) correct position of image of stick

(b) line joining P' to S (dashed line from mirror to P' & arrow)
line joining P to mirror (arrow)
(c) mark the angle of reflection and label it *r*
(d) label position F (dashed line from F to P')

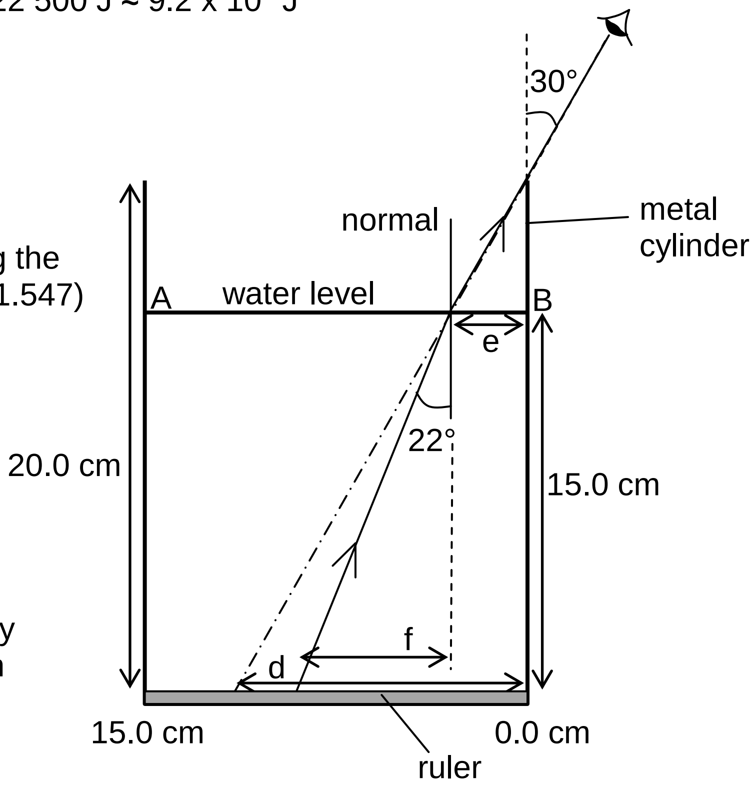


Section B (30 marks)

9(a) $F_{net} = ma = 5250 \times 2.0 = 10\ 500 \approx 11000$ N
(b) label and directions correct

(c) thrust – weight = F_{net} ➔ thrust $= F_{net}$ + weight = 10 500 + 52 500
= 63 000 N
(d)(i) $v^2 = u^2 + 2as$ ➔ $a = (v^2 - u^2)/2s = (0 - 3^2)/2(18)$
$= -0.25$ m s^{-2} deceleration ≈ 0.25 m s^{-2} (2 s.f.)
(ii) thrust – weight = ma ➔ thrust = ma + weight = 5000(0.25) + 50 000
= 51 250 N ≈ 51 000 N (2 s.f.)
(iii) work done = F x d = thrust x height = 51 250 x 18
= 922 500 J ≈ 9.2×10^5 J

10
(a) d: smallest reading seen,
use right-angled triangle
d / 20.0 = tan 30°
➔ d = 11.547 ≈ 11.5 cm
However, due to metal cylinder blocking the eye's view, a slightly larger reading (>11.547) would be seen, so d = 11.6 cm



(b)(i) Use Snell's law: $n_1 \sin \theta_1 = n_1 \sin \theta_1$
From water to air:
1.33 sin *i* = (1.0) sin 30°
➔ sin *i* = (1.0) sin 30°/1.33
i = 22.1° or 22°

(ii) Path of light ray showing refraction away from normal at water level with direction from ruler to water level to eye.
Arrow must be shown.

(iii) e = 5.0 tan 30° = 2.887 cm
f = 15.0 tan 22° = 6.060 cm
smallest reading = e + f = 2.887 + 6.060 = 8.947 ≈ 8.9 cm

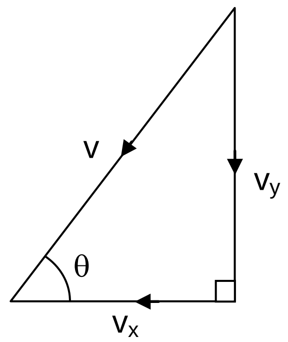
(c) The smallest reading will decrease.
(Note: The emergent angle in air must remain at 30° for the girl to see the reading.)
Since a higher optical density liquid (or liquid with a higher refractive index) causes a larger change in direction of the incident ray / larger deviation of light ray
the angle of incidence must decrease.

(d) The angle of incidence is 0° or incident ray is along the normal
OR angle of incidence is greater (or equal) to critical angle

11 EITHER

(a) sign convention: downwards is positive
vertical motion: $y = u_y t + \frac{1}{2} a_y t^2$ ➔ $26.5 = 0 + \frac{1}{2}(10)t^2$
$t = \sqrt{5.3} = 2.302$ s

(b) horizontal motion: $x = u_x t$ ➔ $u_x = x / t = 8.0/2.302 = 3.475$ m s^{-1}
$t = x / u_x = 1.5 / 3.475 = 0.4317 \approx 0.43$ s



(c) vertical motion: $v_y = u_y + a_y t$ ➔ $v_x = 0 + (10)(2.302)$
$v_x = 23.02 \approx 23$ m s^{-1}

(d) $\tan\theta = v_y / u_x$ ➔ $\tan\theta = 23.02 / 3.475$
$\theta = 81.42 \approx 81°$

(e) The time the diver is in the air would be <u>longer</u> than 5.3 s.

$y = u_y t + \frac{1}{2} a_y t^2$ ➔ $26.5 = \frac{1}{2} a_y t^2$
<u>Air resistance would reduce the vertical acceleration</u> a_y of the diver,
so he takes a longer time to fall the same height of 26.5 m.
OR
vertical direction: $F_{net} = mg - R = ma$
➔ as v increases, R increases, acceleration decreases

11 OR

(a)(i) impulse = mv – mu = 1600 |(0 – 20)| = 32 000 kg m s^{-1} or 32 000 N s

(a)(ii) $F \Delta t$ = impulse
Δt = 32 000 / 640 000 = 0.050 s (2 s.f.)

(b) The principle of conservation momentum states that the
- <u>total momentum of a system remains constant</u>
- <u>if the resultant force on the system is zero</u>.

(c)(i) *Before* *After* *(sign convention: to the right is positive)*
$0 = mu_A + (3m)u$
$u_A = -3u$ or <u>3u to the left</u>

(c)(ii) $3u$ (<u>to the right</u>) (since no loss of k.e.)

(c)(iii) *Before* *After*
$m(3u) + (3m)u = (m + 3m)v$

$v = (6/4)\,u = 1.5u$

(c)(iv) The principle of conservation of momentum is <u>not applicable</u> here
(not valid)
because there is a <u>resultant force on the system exerted by the spring at C</u>.

Note: F_{net} is zero when the spring is just released to push A and B apart!