2018 S3 PHYSICS EOY Markscheme

Paper 1

1……..5	6…….10	11…..15	16…..20	21.….25	26.….30
CBCAB	DABCD	BCCBD	ACCBC	BCDCA	CDBAC

2 B Density of human body is about that of water with density of 1000 kg m^{-3}. V = m ÷ d = 62 ÷ 1000 ≈ 0.060 m^3	**5 B** The ball is thrown up with v= 20 ms^{-1}, the sign convention is "up is positive". The gravitational acceleration on the ball is -10 m s^{-2} throughout the motion of the ball.
10 D a = (v – u) ÷ t = [45 – (-25)] ÷ 0.050 = 1400 m s^{-2} F = ma = 0.050 x 1400 = 70 N	**11 B** When pulled left, the roller rotates anticlockwise due to friction. So friction is acting on the roller to the right.
12 C F = *m* a = *m* [(increase in speed) ÷ *t*] Increase in speed = F *t* ÷ *m* So for constant F, *m* and *t* will affect the increase in speed.	**15 D** Let reading on weighing scale be R Lift moves down, so W – R = m a R = W – ma = 20 N – (2kg)(-2.0 ms^{-2}) = 20 N + 4 N = 24 N
20 C Apply principle of moments about X, Clockwise moment by force on Y = anticlockwise moment by 60 N F_y (15.0 cm) = 60 N (20.0 cm) F_y = 80 N to the left (acts clockwise abt X) Apply principle of moments about Y, Clockwise moment by force on X = anticlockwise moment by 60 N F_x (15.0 cm) = 60 N (20.0 cm) F_x = 80 N to the right (acts clockwise abt Y)	**27 D** Total power input from car = *Fv* Change in GPE = *mgs* sin *α* Useful power output from change in GPE = (*mgs* sin *α*) / t = *mgv* sin *α* Efficiency = useful power output/total power input × 100 % = (*mgv* sin *α*) / (*Fv*) × 100 % = (*mg* sin *α*) / *F* × 100 %

Paper 2 Section A

1(a) **(i)** Ruler or measuring tape, Precision = 0.1 cm or 0.001 m
(ii) Volume = 15.5 cm × 60.2 cm × 41.8 cm = 39000 cm^3 or 0.0390 m^3 (3 s.f.)
(iii) Density = mass ÷ volume = 8.4 kg ÷ 0.0390 m^3 = 220 kg m^{-3} (2 s.f.)

(b) The density of the paper is **greater** than the density of the corrugated cardboard. The density of corrugated cardboard is calculated based on the total mass divided by the total volume of both the paper and the trapped air. Air has a **density** that is significantly **lower** than that of paper. Hence, for the **same** volume, paper has a **greater mass** than corrugated cardboard and therefore has a greater density than corrugated cardboard.

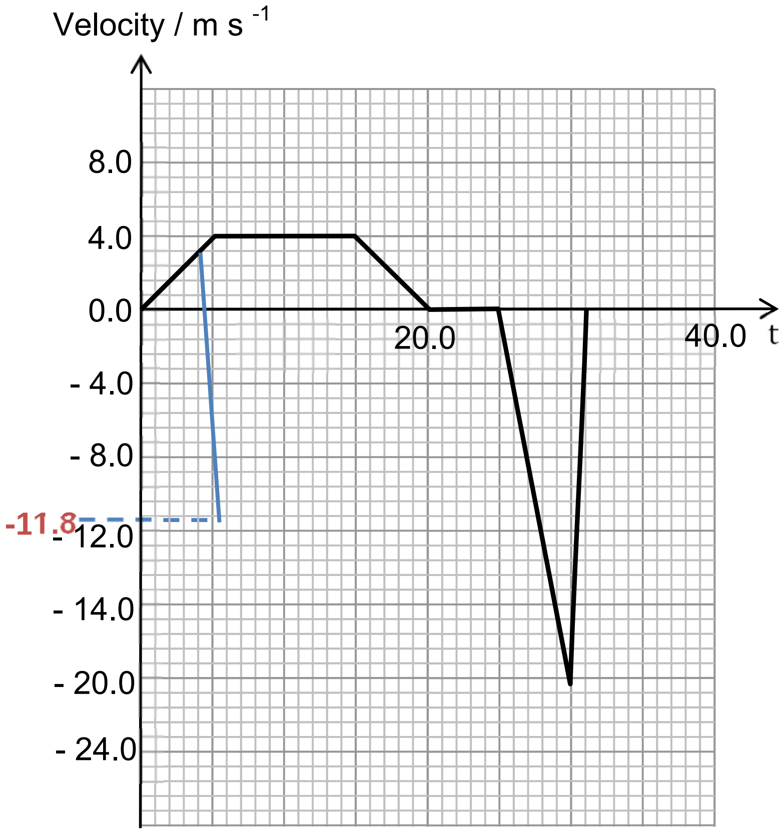
2(a) Velocity is the rate of change of displacement.

(b) The drop correspond to the time from 25 s to 30 s.
Gradient during the drop = acceleration = 24 m s^{-1} ÷ 5 s = 4.0 m s^{-2}
The passengers did not experience free fall with an acceleration of 10 m s^{-2}, as the acceleration is 4.0 m s^{-2}.

(c) **(i)** velocity = 3.2 m s^{-1}

(ii) At 4.0 s, key is at height from ground
= ½ (3.2 ×4.0) m = 6.4 m
Using $s = ut + \frac{1}{2}at^2$ and the sign convention "up is positive",
$-6.4 = 3.2\,t + \frac{1}{2}(-10)t^2$
t = 1.5 s

(iii) Let the final velocity of the key when it hits the ground be v
$v = u + at = 3.2 - 10\,(1.5) = -11.8$ m s^{-1}

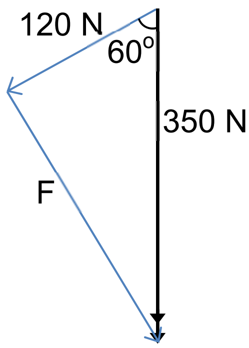


3(a) A scalar is a physical quantity with **magnitude only** whereas a vector is a physical quantity with **magnitude and direction**.

(b) Any vector quantity other than force (e.g. velocity, displacement).

(c) 313 ≥ F ≥ 303 N, 22° ≥ Angle ≥ 18°
Scale: 1.0 cm represents 50 N or 1.0 cm represents 20 N
<u>The following scales are not accepted:</u>

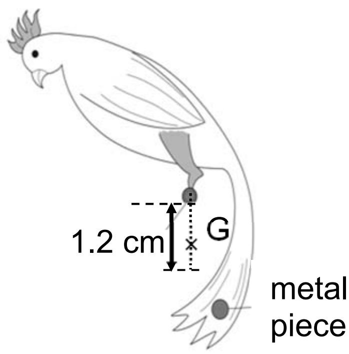
- *1:50 (no units shown)*
- *1 cm = 50 N (length is not equal to force)*
- *Odd scale (e.g. 1.0 cm represents 30 N)*
- *Scale that gives small diagram (e.g. 1.0 cm represent 100 N)*



(d) Any two answers below:

- Increase the angle rope X makes with the vertical.
- Decrease the force in rope X.
- Increase the force in rope X to be greater than 230 N.
  ("increase force on rope X" without stating greater than 230 N is not accepted)

4(a) G marked **vertically below** the rod along the dotted line that is not beyond 1.2 cm below the rod.



(b) **(i)** When the metal piece drops off, the c.g. will shift to **point P** that is the left and above the pivot, within the wood material of the parrot. Point Q is **too far beyond the** wood material of the bird.

(ii) The toy will swing **anticlockwise** about the rod and topple off as the **weight** of the bird acting from point P exerts an **anticlockwise moment** about the rod.

5(a) Pressure at bottom of oil = pressure at bottom of water

$\rho_o g h_o + P_{atm} = \rho_w g h_w + P_{atm}$

$\rho_o\,(16.0) = (1.00 \times 10^3)(15.0)$

$\rho_o = 938$ kg m^{-3} (3 sf)

(b) The mercury level on the left will rise and the mercury level on the right will lower. As alcohol is less dense than oil, the pressure exerted by alcohol would be less than the pressure exerted by the same volume of oil.

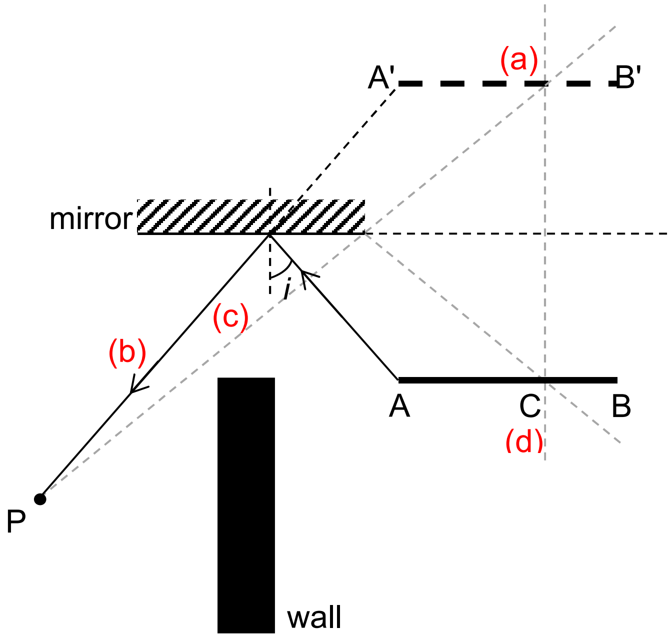
6(a) Position and labelling of A'B'

(b) Line from P to A' & line from mirror to A

(c) Position and labelling of *i*

(d) **(i)** Line from P to image; Position and labelling of C on the object or image.

(ii) Any two of these answers:
- Move the mirror back (away from P)
- Move the mirror to the right (towards the display counter)
- Use a longer mirror that extends towards the display counter
  ["make mirror longer" is not accepted]
- Rotate the mirror anticlockwise
- Use a convex mirror



Section B (30 marks)

7(a) For a system in **equilibrium**, the **total clockwise moments** about a point is equal to the **total anticlockwise moments** about the same point.

(b) **(i)** Moment = 450 N × 2.0 m = 900 Nm clockwise

(ii) When barrier is raised, the moment of the weight of the barrier **decreases** as the **perpendicular distance** from the line of action of its weight to the pivot **decreases**.

(c) Smallest force F acts vertically up at the right end of the barrier.

(d) **(i)** Normal contact force = 0 N

(ii) F × 5.0 m + 200 N × 0.4 m = 450 N × 2.0 m
F = 164 N ≈ 160 N (2 s.f.)

8 **(a)** **(i)** The principle of conservation of energy states that energy cannot be created or destroyed, but only changes from one form to another.

(ii) The lost of kinetic energy is converted into the gain in gravitational potential energy.

(iii) $0.5mv^2 = mgh$ OR $v^2 = u^2 + 2aS$

$0.5(6.0)^2 = 10h$ $\qquad$ $0 = (-6)^2 + 2(-10)S$

$h = 1.8$ m $\qquad$ $S = 1.8$ m

(iv) The maximum height would be four times as much as (a)(iii).
When the speed is twice as fast, the initial kinetic energy possessed by the ball would be four times as much and as such, maximum height would be four times higher. *(not necessary to give exact value of maximum height)*

(b) (i) WD against air resistance = initial KE − gain in GPE

$= 0.5(0.200)(6.0)^2 - 0.200(10)(1.5) = 0.60$ J

OR WD against air resistance = 0.200(10)(1.8-1.5) = 0.60 J

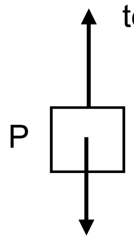
(ii) WD against air resistance = Fs

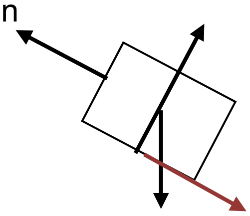
0.60 J = F(1.5); Therefore, F = 0.40 N

9 EITHER

(a) Light string means that the mass of the string is negligible. Inextensible string means that the string cannot be extended / not elastic / not stretchable.

(b)





(c) (i) Force on string = tension T = 45 N

(ii) Let force acting on Q along the slope = friction f

Component of weight along slope = W cos 50^o or W sin 40^o = 25.7 N

T = f + W cos 50^o

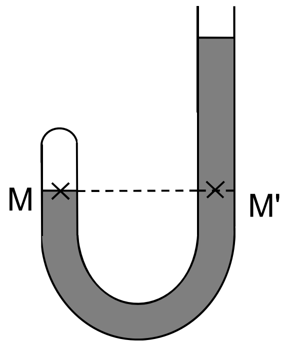
f = 45 N – 40 cos 50^o = 19.2 N = 19 N (2 s.f.)

(iii) When the string breaks, the block **decelerates** (11 m s^{-2}) upwards **to rest** due to a net force of 45 N acting downward. Then it **accelerates** down with a net force of 6.5 N.

9 OR

(a) 1.0×10^5 Pa

(b) Refer to the diagram shown



(c) $P_M = P_{M'}$

$P_G = P_{atm} + \rho g h$

$P_G = 1.0 \times 10^5 + (1.36 \times 10^4)(10)(9.0 \times 10^{-2})$

$= 1.1 \times 10^5$ Pa (2 sf)

(d) fixed mass of gas, constant temperature of gas

(e) $P_1V_1 = P_2V_2$

$(1.0 \times 10^5)(25.0) = (112240)V_2$

$V_2 = 22$ cm^3 (2 sf)

(f) The **height difference would decrease**.

The **volume of the unknown gas would increase**, therefore resulting in a smaller pressure difference between the unknown gas and the atmosphere.