2022 DHS H2 Physics Prelim Paper 1 Suggested Solutions

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
D	**A**	**D**	**D**	**C**	**C**	**B**	**D**	**B**	**B**
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
B	**C**	**C**	**B**	**A**	**B**	**D**	**A**	**D**	**D**
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
A	**B**	**C**	**A**	**C**	**C**	**D**	**A**	**B**	**A**

1 **D** 128 GB = 128 x 10^9 B = 1.28 x 10^{11} B

2 **A** measured length = 891.5 ± 0.5 mm but true length is 895 mm
891.5 mm is lower by 3.5 mm, so not accurate to within 1 mm
results have absolute uncertainty of 0.5 mm, so all are precise to within 1 mm

3 **D** Option A, B and C are the correct equations of motion.

4 **D** Gradient of displacement-time graph gives the magnitude of the velocity of the sphere. After sufficiently long time when the ball reaches terminal velocity (constant velocity), then the graph should be a straight line with positive gradient (velocity same direction as displacement).

5 **C** While it is true in this example that the weight of the book is equal to the force upwards acting on the book from the table, this is not the pair of forces in Newton's third law. The weight of the book is the gravitational pull of the Earth on the book; the 'reaction' force is the gravitational pull of the book on the Earth. The key points to remember for Newton's third law:

The two forces are

1) of the same magnitude (in this case, *W*)

2) in opposite directions (in this case, upwards)

3) acts on different objects (in this case, on the Earth)

4) of the same time (in this case, gravitational)

6 **C** As the ball bounces elastically, no kinetic energy is lost as heat and sound. When the ball hits the horizontal surface it decelerates, losing kinetic energy and gaining elastic potential energy as it is compressed. At some instant, the ball will momentarily have zero velocity and kinetic energy before springing back up, gaining back the original kinetic energy as it does so.

7 **B** Take moment about rear wheel on trailer.

$F(20) = 30(10)$,

$F = 15$ kN

8 **D** Downward force exerted by the cylinder on the surface = pA

By Newton's 3rd law,
downward force exerted by cylinder on surface
= upward force exerted by the surface on the cylinder, N

Since the cylinder is in equilibrium.
$N = W$
$pA = mg$

$$p = \frac{mg}{A} = \frac{\rho Axg}{A} = \rho xg$$

$$\rho = \frac{p}{gx}$$

9 **B** Loss in GPE = gain in KE + energy dissipated by frictional forces

energy dissipated by frictional forces = $mgh - ½\, mv^2$

$= (500)(9.81)(30) - ½(500)(11)^2$

$= 1.2 \times 10^5$ J

10 **B** Energy required per second to raise water

$= mgh / t = (V)gh / t$

$= (1000)\ (0.50)\ (9.81)\ (30) / (60)$

$= 2.45$ kW

As the pump is only 70% efficient, the engine's power = 2.45 / 0.70 = 3.5 kW

11 **B** The net force is the centripetal force = $mr\omega^2$

For the 5.0 kg mass, the net force = $(5.0)(2.0)\omega^2 = 10\omega^2$

For the 8.0 kg mass, the net force = $(8.0)(6.0)\omega^2 = 48\omega^2$

Same ω for both masses, hence the ratio is 10: 48 = 5: 24

12 **C**

$$g = \frac{GM}{r^2} = \frac{G}{r^2}\left(\rho\frac{4}{3}\pi r^3\right) = \frac{4\pi G\rho}{3}r$$

For the sphere of twice the radius, the gravitational field strength is doubled i.e. $2X$.

13 **C** For geostationary satellite, T = 24 hours.

For circular motion, $v = r\omega = \dfrac{2\pi r}{T} = \dfrac{2\pi(6.40 \times 10^6 + 3.59 \times 10^7)}{24 \times 60 \times 60} = 3.08 \text{ km s}^{-1}$

14 **B** a-t and x-t graphs for a body undergoing s.h.m. are π rad out of phase

15 **A**

total $E \propto \omega^2 x_0^2 \propto \left(\dfrac{1}{T}\right)^2 x_0^2$ where T is period and x_0 amplitude

$$\frac{E_2}{E_1} = \left(\frac{T_1}{T_2}\right)^2 \left[\frac{(x_0)_2}{(x_0)_1}\right]^2 = \left(\frac{T_1}{3T_1}\right)^2 \left[\frac{2(x_0)_1}{(x_0)_1}\right]^2 = \frac{4}{9} \Rightarrow E_2 = \frac{4}{9}E_1 = \frac{4}{9}(18 \text{ mJ}) = 8 \text{ mJ}$$

16 **B**

$T = \dfrac{1}{f} = \dfrac{1}{5000} = 0.20 \text{ ms}$

Since T is represented by 2 horizontal squares (2 cm),

time base setting = $\dfrac{0.20}{2} = 0.10 \text{ ms cm}^{-1} = 100 \text{ μs cm}^{-1}$

17 **D** If the waves meet in phase at O, then path difference = OY − OX = XY = $n\lambda$

Since λ = 0.75 m, then n = 2, for XY = 1.50 m

18 **A** From single slit diffraction formula, $\sin\theta = \lambda / b$

or $x / D = \lambda / b$ where D is the distance from slit to screen

B, C and D are correct as seen from the equation. However, when slit width is is increased, more light passes through the slit and the intensity increases. Hence the area under the graph increases.

19 **D** Time for electron to travel in electric field, $t = \dfrac{s_x}{u}$

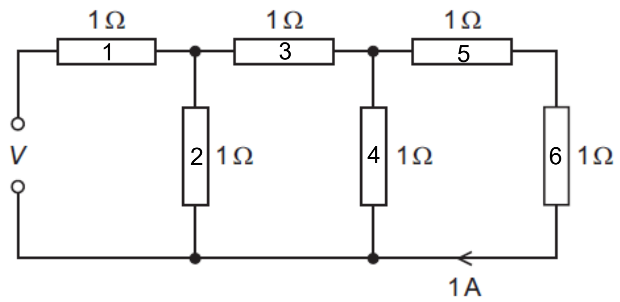
At t, displacement $s_y = \dfrac{1}{2}at^2 = \dfrac{1}{2}a\left(\dfrac{s_x}{u}\right)^2$

Since a, u are constants, $s_y \propto s_x^2$

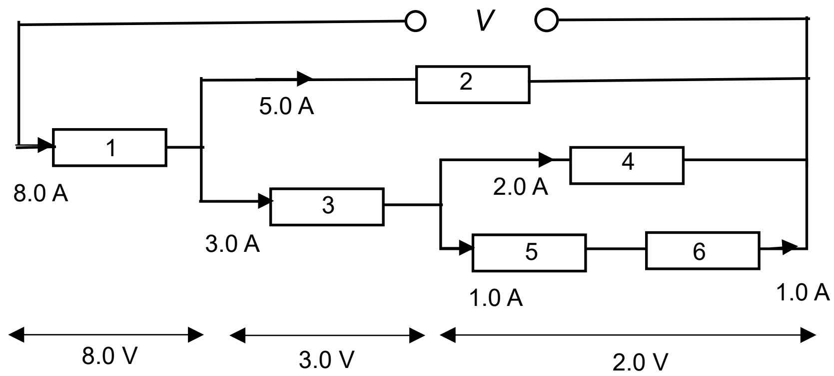
$p = kx^2 = 1.0 \text{ mm}$

Thus $q = k(2x)^2 = 4p = 4.0$ mm and so on.

20 **D**

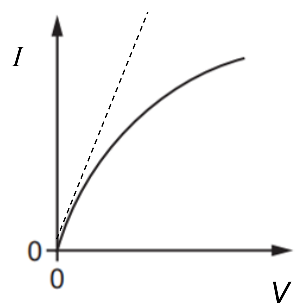


The above circuit when re-drawn is same as the circuit below



Then the currents and p.d. across the other resistors can be found.
$V = 8.0 + 3.0 + 2.0 = 13.0$ V

21 **A** The I-V graph for a filament lamp is as follows:



The corresponding V-I graph is a reflection of the graph about the dotted line.

22 **B** Resistors are connected in parallel, thus they have same p.d.

$2I_1 = 3I_2 = 4I_3$ (1)

$I_1 + I_2 + I_3 = I$ (current from power supply) (2)

Sub (1) into (2): $(3/2)I_2 + I_2 + (3/4)I_2 = I$

So $I_2 = (4/13)\,I$ (3)

Sub (3) into (1) gives $I_1 = (6/13)\,I$ and $I_3 = (3/13)\,I$

So $I_1 : I_2 : I_3 = 6 : 4 : 3$

23 **C** $F = BIL\sin\theta = \left(4\times10^{-5}\right)(3)(2)\sin 90° = 240$ μN

24 **A** A neutral point (i.e., a point of zero magnetic field) is possible at a position where the magnetic flux densities from 2 current sources are in opposite direction and of the same magnitude.
Using Right-Hand Grip Rule, this point can only be achieved at region 2.

25 **C** Current is able to flow both ways due to two diodes in opposite directions. One of the diodes is connected in series to another resistor, which reduces current in that direction.

26 **C** Since magnitude of emf is proportional to rate of change of flux, when flux is constant, no emf is induced and when flux changes linearly, a constant emf is induced.

27 **D** Einstein's equation: $hc/\lambda = \phi + e\,V_S$

When wavelength is halved, the photon energy is doubled. Since the work function remains unchanged because the same metal is used, the max kinetic energy of the photoelectron and consequently the stopping voltage will be more than doubled.

28 **A** Uncertainty principle apply in the same direction and at the slit when the electron undergoes diffraction at the slit.

29 **B** $^{28}_{8}O$: 8 protons, 20 neutrons (doubly magic)

$^{40}_{20}Ca$: 20 protons, 20 neutrons (doubly magic)

$^{56}_{26}Fe$: 26 protons, 30 neutrons (**not** doubly magic)

$^{50}_{28}Ni$: 28 protons, 22 neutrons (**not** doubly magic)

$^{126}_{50}Sn$: 50 protons, 76 neutrons (**not** doubly magic)

30 **A** From the figure, background count rate can be estimated to be 8 s^{-1}.
Subsequently, half-life can be estimated as the time duration for the count rate to decrease from 58 (=50+8) to 33 (=25+8). Best option is 60 s.