Year 11 **Physics**

Practice Exam 1 (Unit 1 & 2) **Answers**

Unit 1

Area of Study 1 **How can thermal effects be explained?**

Question 1

a A change in the potential energy of the particles in a substance can lead to expansion or a change of state. (2 marks)

b A change in the average kinetic energy of the particles in a substance leads to a change in temperature. (1 mark)

Question 2

a $\Delta U = Q - W$

$= -10 - (-150)$

$= -10 + 150$

$= 140$ kJ (Internal energy increases by 140 kJ) (2 marks)

b The thermal energy of the hotter water decreases as it is transferred to the cooler water. As a result, the energy of the cooler water increases. This ceases when the two parts of the water reach thermal equilibrium (that is, they are at the same temperature). (3 marks)

The same occurs for the water and surrounding air. Thermal energy is transferred from the water to the surrounding air until thermal equilibrium is reached.

c Use $e = 0.95$, $\sigma = 5.67 \times 10^{-8}$, $A = 0.1\text{ m} \times 0.1\text{ m} \times 6 = 0.06\text{ m}^2$, $T = (273+90) = 363$ K and $T_s = (273+20) = 293$ K

$P = e\sigma A(T^4 - T_s^{\,4})$

$P = 0.95 \times 5.67 \times 10^{-8} \times 0.06\,[(363)^4 - (293)^4]$

$P = 32.3$ W (3 marks)

Question 3

a energy lost by cocktails = energy gained by melting ice

$mc\Delta T$ (cocktails) = mL_{fusion} (ice)

$0.06 \times 2.7 \times 10^3 \times 26 = m(\text{ice}) \times 3.34 \times 10^5$

$m(\text{ice}) = \dfrac{(4.212 \times 10^3)}{(3.34 \times 10^5)} = 0.0126$ kg or 12.6 g (3 marks)

b energy lost by cocktails = energy gained by melting ice to water and heating water.

$mc\Delta T(\text{cocktails}) = mL_{\text{fusion}}(\text{ice}) + mc\Delta T(\text{water})$

$0.06 \times 2.7 \times 10^3 \times 16 = m(\text{ice}) \times [(3.34 \times 10^5) + (4.2 \times 10^3 \times 16)]$

$m(\text{ice}) = \dfrac{(2.592 \times 10^3)}{(4.01 \times 10^5)} = 0.006\,46$ kg or 64.6 g (4 marks)

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c $E = P \times t = mc\Delta T$

$2000 \times t = 1.20 \times 4.2 \times 10^3 \times (100 - 26)$

$t = 372\,960 \div 2000 = \frac{186}{60}$ s = 3.1 ~ 3 min (2 marks)

d Explanation: Water vapour in the air next to the glass cools and liquefies producing the water droplets. (2 marks)

Description: As heat passes from the glass to the droplets they evaporate again, thus cooling the glass itself, which helps keep the contents cool too. (2 marks)

Question 4

a 50°C (The melting temperature is shown by the plateau, i.e. flat section, on the graph.) (1 mark)

b E = 50 J for 5 minutes = $m \times L_{fusion}$

$50 \times 5 \times 60 = 0.25 \times L_{fusion}$

$L_{fusion} = \frac{15\,000}{0.25} = 6.0 \times 10^4$ J kg^{-1} (2 marks)

Question 5 (3 marks)

Star A:

$\lambda_{max}T = 2.898 \times 10^{-3}$ m K

$T = \frac{2.898 \times 10^{-3}}{700 \times 10^{-9}}$

$T = 4140$ K

Star B:

$\lambda_{max}T = 2.898 \times 10^{-3}$ m K

$T = \frac{2.898 \times 10^{-3}}{620 \times 10^{-9}}$

$T = 4674$ K

Question 6

a The greenhouse effect describes how the Earth's atmosphere traps heat energy from the Sun. When the Sun's energy reaches the Earth's atmosphere, part of this radiation is reflected back to space without reaching Earth. The remaining is absorbed and re-radiated by greenhouse gases (carbon dioxide, methane, nitrous oxide, etc) in the atmosphere. The absorbed radiation heats up the atmosphere and the Earth's surface. This is essential to maintain the temperature balance required to allow life on Earth to exist. (2 marks)

b The enhanced greenhouse effect refers to trapping or absorbing too much of the Sun's radiation causing the Earth to heat up further, due to the elevated concentrations of greenhouse gases in the atmosphere. Scientist believe this has been caused as a result of human activities, particularly burning fossil fuels (coal, oil and natural gas). (2 marks)

Question 7 (1 mark)

C. The atmosphere is a fluid and so convection currents are the most effective way for heat to move through it.

Question 8 (2 marks)

Double-glazed windows have two sheets of glass with a small air gap between them. The air trapped in the gap is an insulator, reducing heat conduction through the window. The fact that the air is trapped and cannot circulate reduces the effect of convection. (Note: Double glazing has minimal effect on radiation.)

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Area of Study 2 How do electric circuits work?

Question 9

a Calculate the effective resistance for the parallel part of the circuit first.

$\frac{1}{R_{parallel}} = \frac{1}{200} + \frac{1}{600}$

$\frac{1}{R_{parallel}} = \frac{4}{200} = \frac{1}{150}$

$R_{parallel} = 150\ \Omega$

$R_{total} = 150 + 650 = 800\ \Omega$ (3 marks)

b Firstly, calculate the total current flowing in the circuit:

$I = \frac{V}{R} = \frac{6.0}{800} = 7.5 \times 10^{-3}$ A or 7.5 mA

$V_{parallel}$ pair $= I \times R = 7.5 \times 10^{-3} \times 150 = 1.125$ V

$I_{600} = \frac{V}{R} = \frac{1.125}{600} = 1.88 \times 10^{-3}$ A or 1.88 mA (3 marks)

Question 10

a $Q = I \times t = 1.9 \times 10^{-3} \times 1.00 \times 10^{-4} = 1.90 \times 10^{-7}$ C (2 marks)

b number of electrons $= \frac{q}{(1.6 \times 10^{-19})}$

number of electrons $= \frac{(1.9 \times 10^{-7})}{(1.6 \times 10^{-19})} = 1.19 \times 10^{12}$ electrons (2 marks)

c $E = V \times Q \times 20$ pulses in 2 seconds $= 350 \times 1.90 \times 10^{-7} \times 20 = 1.33 \times 10^{-3}$ J (3 marks)

Question 11

a Because X and Y are connected in series the current flowing through them will be 50 mA. (3 marks)

Using this information and reading directly from the graph gives:

$V_X = 3.0$ V and $V_Y = 5.0$ V

$V_{supply} = V_X + V_Y = 3.0 + 5.0 = 8.0$ V

b $R = \frac{V}{I} = \frac{3}{0.050} = 60\ \Omega$ (2 marks)

c Conductor X is an example of a non-ohmic conductor.

The reason why conductor X is non-ohmic is because its voltage-current graph is not a straight line, but rather a non-linear curve. This indicates that the resistance (i.e the ratio of *I* to *V*) is not constant across all values of voltage and current. (2 marks)

d Conductors X and Y are now connected in parallel. This means that the potential difference across them will be the same and that the circuit current will be equal to the sum of the currents flowing through them. Using this information and reading directly from the graph gives:

$I_X = 60$ mA and $I_Y = 60$ mA

$I_{total} = I_X + I_Y = 60 + 60 = 120$ mA (2 marks)

e $P = V \times I = 6.0 \times 0.060 = 0.36$ W (2 marks)

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Question 12

a $E = P \times t$

For globe 1: $E = 100 \times 1 \times 60 \times 60 = 3.6 \times 10^5$ J (per hour)

For globe 2: $E = 20 \times 1 \times 60 \times 60 = 7.2 \times 10^4$ J (per hour) (2 marks)

b For globe 1, the total energy used during its lifetime would be:

$E_{\text{globe 1}} = 3.6 \times 10^5 \times 1000 = 3.6 \times 10^8$ J

Cost to run = \$0.208 per kWh (where 1 kWh = $1000 \times 60 \times 60 = 3.6 \times 10^6$ J)

To match globe 2's lifetime of 10 000 hours, 10 of globe 1 would be needed.

Cost of globe 1 = 10 × purchase price = 10 × \$1.20 = \$12.00

Cost to operate globe 1 for 10 000 hours = $10 \times 3.6 \times 10^8 \div (3.6 \times 10^6) \times \$0.208 = \$208$

Total cost of globe 1 = \$12 + \$208 = \$220

For globe 2, the total energy used during its lifetime would be:

$E_{\text{globe 2}} = 7.2 \times 104 \times 10\,000 = 7.2 \times 10^8$ J

Cost to operate globe 2 for 10 000 hours = $7.2 \times 10^8 \div (3.6 \times 10^6) \times \$0.208 = \$41.60$

Total cost of globe 2 = \$5.60 + \$41.60 = \$47.20

∴ globe 2 is much more economical to run. (6 marks)

Question 13

a $V_{\text{out}} = 2$V so $V_{\text{thermistor}} = 6$V

Therefore $V_{\text{thermistor}}$ is $3 \times V_{\text{out}}$

And $R_{\text{thermistor}}$ is $3 \times R_{\text{out}} = 3 \times 1\ \text{k}\Omega = 3\ \text{k}\Omega$

This corresponds to approximately 25°C in the graph. (3 marks)

b $V_{\text{out}} = 3$V so $V_{\text{thermistor}} = 5$V

At 20°C, $R_{\text{thermistor}}$ is 5 kΩ

$V_{\text{thermistor}} = I \times R_{\text{thermistor}}$

$5 = I \times 5\ \text{k}\Omega$

$I = 0.001$ A

$V_{\text{out}} = I \times R_{\text{out}}$

$3 = 0.001 \times R_{\text{out}}$

$R_{\text{out}} = 3\ \text{k}\Omega$

(Alternatively, ratios can be used to solve this) (3 marks)

Question 14

In a properly functioning circuit, the current in the active and neutral wires is the same. If it is not the same, the circuit is not functioning correctly. (2 marks)

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Unit 1

Area of Study 3 What is matter and how is it formed?

Question 15 (3 marks)

Heavier elements first formed in the early stars. When hydrogen fuel was used up it led to supernovae and the formation of these heavier elements.

Question 16 (2 marks)

The mass of matter and its antimatter particle is the same. Their charges, however, are opposite.

Question 17 (2 marks)

Radioisotopes are isotopes of the same element that are also radioactive. They contain the same number of atomic protons but different number of neutrons in their nuclei. Ni-63 is radioactive due to the extra 5 neutrons it has in its nucleus, which makes it less stable compared to Ni-58. (To become more stable the Ni-63 atom undergoes radioactive decay to 'lose' its excess energy.)

Question 18 (2 marks)

Nuclear binding energy is the energy that holds an atomic nucleus together. It is the energy needed to totally separate the protons and neutrons in the nucleus.

Question 19 (2 marks)

X is 3 neutrons (${}^{1}_{0}n$)

(In a nuclear equation the total number of nucleons and the number of protons on each side of the equation must be equal. The right-hand side of the equation requires three more neutrons to achieve balance.)

Question 20

a (4 marks)

$$\boxed{63}\atop\boxed{28}\,\mathrm{Ni} \rightarrow {\boxed{63}\atop\boxed{29}}\,\mathrm{Cu} + {\boxed{0}\atop\boxed{-1}}\,\beta + \text{energy}$$

(1/2 mark for each correct box)

b The β^- -particle was emitted from the atom's nucleus after one of the atom's neutrons turned into a proton and an electron. (The electron being the beta minus particle) (2 marks)

Question 21

a $E = 7.39 \times 10^6 \times 1.6 \times 10^{-19}$

$= 1.18 \times 10^{-12}$ J (2 marks)

b $E = 100\,000 \times 34$ eV

$= 3.4 \times 10^6$ eV (or 3.4 MeV) (2 marks)

c distance = $\frac{7.39}{3.4}$ MeV of energy lost per cm = 2.17 cm or 22 mm (2 marks)

d $N = N_0(\frac{1}{2})^n$

n = number of half-lives that have passed = $(4.13 \times 10^{-3}) \div (1.78 \times 10^{-3}) = 2.32$

$N = 100 \times (\frac{1}{2})^{2.32} = 20\%$ (3 marks)

Question 22

(3 marks)

$E = mc^2$

$= 2.09 \times 10^{-28} \times (3 \times 10^8)^2$

$= 1.881 \times 10^{-11}$ J

In eV: $\frac{1.881 \times 10^{-11}}{1.6 \times 10^{-19}}$ = 117 562 500 eV = 118 MeV

Question 23

(2 marks)

Hydrogen nuclei at a distance experience mainly electrostatic repulsion. At small distances, the strong nuclear force dominates. To get to this point, however, hydrogen nuclei need enormous amounts of energy (to overcome the repulsion and fuse.)

Question 24

(2 marks)

$\Delta E = E_3 - E_2$

$= -1.51 - (-3.39)$

$= 1.88$ eV

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Unit 2

Area of Study 1 How can motion be described and explained?

Question 25

a $u = 15$, $t = 1.2$, $a = 0$, $s = ?$

$s = ut + \frac{1}{2}at^2$

$s = 15 \times 1.2 + 0 = 18$ m (2 marks)

b $u = 15$, $v = 0$, $t = 4.4$, $a = ?$

$v = u + at$

$0 = 15 + 4.4a$

$a = -15 \div 4.4 = -3.41$ m s^{-2}, so the magnitude of deceleration is 3.41 m s^{-2} (2 marks)

c Stopping distance (SD) = Reaction distance (RD) + Braking distance (BD)

RD = 18 m (from part b)

BD: $u = 15$, $v = 0$, $t = 4.4$, $a = -3.41$, $s = ?$

$s = \frac{1}{2}(u + v) \times t$

$s = \frac{1}{2}(15 + 0) \times 4.4 = 33$ m

$\therefore$ stopping distance = 18 + 33 = 51 m (3 marks)

d work done = force × distance

$F = m \times a$

$F = 1600 \times 3.41 = 5456$ N

$W = 5456 \times 33 = 180\,048$ J or 1.80×10^5 J (3 marks)

Question 26

a Acceleration = gradient of the v–t graph at $t = 60$ s

gradient = $\frac{\text{rise}}{\text{run}} = \frac{0 - 15}{65 - 50} = -1.0$ m s^{-2}

$\therefore$ acceleration = 1.0 m s^{-2} (2 marks)

b $F_{net} = 0$ (constant velocity means $a = 0$ and $F_{net} = ma$) (1 mark)

c Acceleration = gradient between $t = 0$ and $t = 10$ s

gradient = $\frac{\text{rise}}{\text{run}} = \frac{0 - 15}{0 - 10} = 1.5$ m s^{-2}

$F_{net} = m \times a = 32\,000 \times 1.5 = 48\,000$ N

$F_{net} = F_{driving} - F_{resistive}$

$48\,000 = 61\,300 - F_{resistive}$

$\therefore F_{resistive} = 61\,300 - 48\,000 = 13\,300$ N or 13.3 kN (3 marks)

d The bus's average speed will be equal to distance it covers over time. The distance covered is equal to the area under the graph.

Area = $(\frac{1}{2} \times 10 \times 15) + (40 \times 15) + (\frac{1}{2} \times 15 \times 15) + (25 \times 0) + (\frac{1}{2} \times 10 \times 10) + (25 \times 10) + (\frac{1}{2} \times 15 \times 10) + (10 \times 0)$

$= 75 + 600 + 112.5 + 0 + 50 + 250 + 75 + 0$

$= 1162.5$ m

Average velocity = $1162.5 \div 150 = 7.75$ m s^{-1} (3 marks)

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Question 27 (2 marks)

The force due to gravity on the gymnast is due to the force that the Earth exerts on him.

According to Newton's third law: $F_{A\ on\ B} = -F_{B\ on\ A}$. So the reaction force to the force due to gravity acting on the gymnast is the gravitational force that the gymnast exerts on the Earth.

(Remember that Newton's third law involves the forces acting on two bodies that are interacting with each other—in this case the gymnast and Earth. Equal and opposite reaction forces act on DIFFERENT objects. The tension force in the rings is acting on the gymnast so it is not the reaction force to the gymnast's weight.)

Question 28 (3 marks)

$u = 0$, $v = 17.8$, $t = 9.4$, $a = ?$

$v = u + at$

$17.8 = 0 + 9.4a$

$a = \frac{17.8}{9.4}$

$= 1.89 \text{ m s}^{-2}$

$Fnet = m \times a$

$= 1000 \times 1.89$

$= 1890 \text{ N or } 1.89 \times 103 \text{ N}$

Question 29

a $E_s = \frac{1}{2} k x^2$

$= \frac{1}{2} \times 500 \times (0.1)^2$

$= 2.5 \text{ J}$ (2 marks)

b $E_s = E_k = \frac{1}{2} mv^2$

$2.5 = \frac{1}{2} \times 0.1 \times v^2$

$v^2 = 50$

$v = 7.07 \text{ m s}^{-1}$ (2 marks)

c $E_s = E_k = E_g = mg\Delta h$

$2.5 = 0.1 \times 9.8 \times \Delta h$

$\Delta h = 2.55$ m (above the flat portion of the track) (2 marks)

Question 30

a $m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$0.3 \times 2 + 0.1 \times (-2) = 0.4 \times v$

$0.6 - 0.2 = 0.4v$

$v = 1 \text{ m s}^{-1}$ east (2 marks)

b $\eta = \frac{\text{useful energy}}{\text{total energy}} \times 100$

$= \frac{\text{final } E_k}{\text{initial total } E_k} \times 100$

$= \frac{0.5 \times 0.4 \times 1^2}{0.5 \times 0.3 \times 2^2 + 0.5 \times 0.1 \times 2^2} \times 100$

$= \frac{0.2}{0.8} \times 100$

$= 25\%$ (3 marks)

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Question 31

a $F_1 + mg = F_2$

$F_1 + 25 \times 9.8 = F_2$

$F_1 + 245 = F_2$ (1 mark)

b $F_1 \times 0.5 = mg \times 1$

$0.5\ F_1 = 245$ (1 mark)

c $0.5\ F_1 = 245$

so, $F_1 = \frac{245}{0.5} = 490$ N

$F_1 + 245 = F_2$

so, $F_2 = 490 + 245$

$= 735$ N (3 marks)

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